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NOTES FROM THE GEOLOGICAL LABORATORY.

EDITED BY PROFESSOR WILLIAM BULLOCK CLARK, PH. D.

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Description of the Geological Excursions made during the Spring of 1895. By WILLIAM B. CLARK.

In accordance with the established custom of the Geological Department one or more extended geological excursions are made each spring to visit either the Cretaceous-Tertiary series of the Coastal Plain or the Paleozoic formations of the Appalachian Mountains.

During the month of May of the present year two such expeditions were undertaken—the first to examine the section of fossiliferous strata exposed along the banks of the Potomac River, and the second to the Natural Bridge, Luray Caverns and Massanutten Mountain in the Appalachian region of Virginia.

There were twenty-one altogether who took part in these excursions.

FIRST EXCURSION TO THE COASTAL PLAIN.

The first expedition, which was made upon a small steamboat specially engaged for the purpose, embraced an examination of the Cretaceous-Tertiary formations for nearly fifty miles along the banks of the Potomac River from Washington southward. In this area of the Coastal Plain are found exposed representatives of all the formations from the Cretaceous to the Pleistocene, no other section affording a more complete sequence of the different members of the series, or more highly fossiliferous strata. Extensive collections were made at many points.

The Cretaceous.—The Cretaceous deposits have been divided into several formations, which, with the exception of the lowest member, find their more complete development in the area to the northward, especially upon the eastern shore of Maryland and in New Jersey.

The lowest member known as the "Potomac formation," from its extensive development in the Potomac region, is well exhibited upon the Maryland bank at Fort Foote and at the base of the bluff at Fort Washington; while upon the Virginia side numerous exposures are found all along the shore as far as Aquia Creek. The formations consist for the most part of sands and clays—the latter highly colored and variegated, and characterizing the upper beds. The life is largely reptilian and plant, few molluscan

forms having been thus far detected. The life characteristics will be considered by Mr. Bibbins in another article in this number.

The overlying formations, which are more distinctly marine in character, have been already described by the writer in several papers upon the Geology of the Coastal Plain. The lowest of these formations, the "Matawan formation," occurs with numerous fossils, overlying the Potomac formation at Fort Washington, while the next two divisions, the "Navesink" and "Redbank formations," so well developed a little farther to the northward, appear sparingly in this area. In the absence of fossils it is doubtful whether the "Rancocas formation" occurs at any point along the Potomac bluffs, although well developed in the banks of the Severn River, thirty miles to the northward.

The Matawan formation consists typically of black micaceous sands and clays, while the Navesink, Redbank and Rancocas formations are characterized by greensand beds, although the glauconite may be at times sparsely represented or extensively weathered. Often chiefly arenaceous, they may become at times argillaceous.

The Eocene.—The Eocene deposits are more extensively exposed in the Potomac bluffs than anywhere else in the Middle Atlantic coastal plain, and are by far the most fossiliferous zone in that portion of the valley which was visited. More time was spent in examining the Eocene strata and collecting from its highly fossiliferous layers than in other work, and the bluffs at Clifton Beach, Aquia Creek, Potomac Creek, Woodstock, and Pope's Creek were visited. The Eocene strata in this area consist largely of greensand marls which become in places thoroughly indurated, so that firm limestone ledges are formed, which are well exhibited at Aquia Creek and other points. More than 100 species of fossils have been found in this region, some ranging throughout the formation, although others are restricted, apparently, to definite zones. As stated in a later article the Eocene deposits of this area represent the greater part of the Eocene series of the Gulf, with the possible exception of its upper members. Darton has given the name of "Pamunkey formation" to the deposits.

The Neocene.—The Neocene of the Potomac area is characterized by two very distinct types of deposits.

The first represents the Miocene, and has been called the "Chesapeake formation." It is highly fossiliferous and consists of sands, clays and marls, together with a thick deposit of diatomaceous earth at the base of the formation. The latter is well exhibited at Pope's Creek overlying the Eocene, where some thirty to forty feet of the materials are found capping the top of the bluff. From this point they gradually dip south-eastward, reaching water-level a few miles below. Above the diatomaceous beds the fossiliferous marls have yielded an abundant fauna, but are not well exhibited within the area visited.

The upper member of the Neocene series is thought to represent the Pliocene and has been called the "Lafayette formation." It occupies the higher levels of the Potomac Valley overlying the earlier deposits of the Coastal Plain, and consists of gravels, sands and loams, the coarser elements predominating. The pebbles are iron-stained and often imbedded in a highly colored loam. Arkose is also not uncommon.

The Pleistocene.—The Pleistocene strata of the Coastal Plain, southward from New Jersey, have been termed the "Columbia formation" by McGee. In the Potomac region this formation is found at the lower levels and is composed of gravels, sands and loams, although, in the vicinity of the river, the materials are more often coarse and irregularly stratified. Numerous terraces were observed along the river overlying, unconformably, the other members of the Cretaceous-Tertiary series.

Second Excursion to the Appalachian Region.

Upon the second expedition several places not only of scientific but popular interest were visited. Both at the Caverns of Luray and the Natural Bridge the managements extended special privileges to the party. We are particularly under obligation to Mr. J. Kemp Bartlett, Jr., Secretary of the Luray Caverns Company for making arrangements for our visit there, and for the special opportunities which were granted for a study of those portions of the caverns not commonly entered by tourists.

Mr. Bailey Willis, Lecturer upon Stratigraphic and Structural Geology, took charge of the party after the places of popular interest had been visited, and gave to those present the benefit of his exhaustive knowledge of Appalachian geology.

The Luray Caverns.—One of the most enjoyable features of the excursion was the visit to the wonderful Caverns of Luray. Of great popular interest on account of the marvelous beauty of their stalactitic and stalagmitic formations they, at the same time, richly reward the geological student for careful examination.

These immense subterranean passages have been opened out in the *Shenandoah limestone*, one of the most important members of the Appalachian series, and which underlies the Great Valley throughout most of its extent from New York to Alabama. In northern Virginia this formation reaches several thousand feet in thickness, and is composed mainly of impure limestones, generally dolomitic, with which are locally interbedded shales or sandstones. The fossils found indicate that the deposits embrace portions of two geological divisions—the basal beds being Cambrian, the uppermost, Lower Silurian. The strata have been subjected to considerable deformation of various kinds. Folds and faults are conspicuous, and are often continuous over great distances, extending generally from north-east to south-west; while the beds have a prevailing dip to the south-east. These structural features are much more strikingly developed in the Appalachian Valley in northern Virginia than in the states to the north, but become intensified to the southward.

It is from deposits and under conditions just described that the subterranean waters have removed in solution great quantities of material from the purer limestone beds, leaving cavernous openings at many points throughout the Appalachian Valley. This effect of percolating water may be seen upon the surface, where the roofs of such caverns have fallen in, leaving broad undrained depressions or sinks, in which surface water often accumulates, forming ponds or marshes. The amount of mineral matter thus removed in solution, in limestone districts, has been estimated to aggregate, annually, many tons per square mile of surface.

Within the caves the permeating water, accumulating in drops upon the roof, partially evaporates, and by the loss of carbonic acid can no longer hold all its carbonate of lime in solution. This is then deposited about the edges of each drop, to be further increased as other drops are added, and thus the accumulation gradually grows to form the stalactite. This upon examination is found to be composed of concentric zones of growth, crossed by radiating fibres, each fibre being considered to represent a crystal of calcite with the principal axis of the prism at right angles to the surface of deposit.

A portion of the water accumulated upon the roof falls to the floor of the cavern and is further evaporated, forming in the manner already described the stalagmite. As growth continues above and below, the stalactite and stalagmite may be united to form a solid column from roof to floor. At times similar materials may be accumulated along some line or fissure, producing a broad pendant, which, by union below, may form a solid wall. All manners of fantastic shapes may be developed, but they can all be explained by the simple process just mentioned.

The Natural Bridge.—Few objects in nature have elicited more interest than the Natural Bridge of Virginia. The gigantic proportions of this magnificent arch call forth the wonder and admiration of the spectator, and if he be a geologist, a desire to find an explanation for its existence.

The geological formations of the region consist of more or less altered limestones and shales of middle and upper Cambrian age, succeeded by the massive Knox dolomite (Shenandoah limestone), the Natural Bridge itself being found at the axis of a marked syncline in these beds. Directly at the bridge then the strata are nearly horizontal, but both above and below the angle of dip increases rapidly. This position of the beds has an important bearing upon the power of resistance which the bridge has to erosion, the upturned strata both above and below being much more rapidly removed. Regarding the original inception of the Natural Bridge, it is reasonably certain that some underground passage was opened through the massive and fissured limestone at a time when the stream was but little if any lower than the present summit of the bridge, and that this gradually became enlarged as the gorge was excavated, the proportions of the bridge at the same time diminishing as erosion went on. It is only a matter of time, although doubtless of many centuries, when the Natural Bridge will entirely disappear by the same processes which produced it.

The Massanutten Mountain.—Few areas more strikingly illustrate the normal structure of the central Appalachian district than does the Massanutten Mountain. Situated in the middle of the Great Valley of the Appalachians and flanked upon either side by the *Shenandoah Limestone*,

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earlier described, it is itself composed of higher members of the Paleozoic series. Subjected to the deformation characteristic of this part of the Appalachian region, in which extensive folding and some faulting are found, it affords a circumscribed district for study, that has few equals. As this area has been assigned to Mr. Spencer for investigation, he will present in a subsequent article a preliminary account of its general features, so that only a few words need be given here.

The *Shenandoah limestone*, above mentioned, is overlain in turn by the *Martinsburg shale* (Hudson River), and the *Massanutten sandstone* (Medina), the only formations examined by the party in the section made from Luray to Newmarket, although in other portions of the region these divisions are succeeded by the *Rockwood formation* (Clinton), the *Lewiston limestone* (Lower Helderberg), the *Romney shales* (Hamilton), and probably also the *Jennings formation*.

Upon the return journey a half day was spent in examining the geological formations in the vicinity of Harper's Ferry, the ascent of Maryland Heights being made by the party.

Two new Brachiopods from the Cretaceous of New Jersey. By William B. Clark.

The Cretaceous deposits of New Jersey have afforded an abundant fauna in which several species of Brachiopoda have been recognized. One of these, the *Terebratula harlani*, is a common form, and the most characteristic fossil of the Rancocas formation (middle marl bed) throughout the northern Atlantic coastal plain.

The two species below described are of interest as the first representatives of the genus *Cistella* reported from American Cretaceous strata. They come from the upper portion of the Rancocas formation in the calcareous beds overlying the *Terebratula harlani* zone. All the specimens thus far obtained were found in the pits on the south bank of Rancocas creek about one-half mile below Vincentown. This same locality has also afforded large numbers of shells of Echinodermata, Bryozoa, and Foraminifera.

Cistella beecheri, n. sp.

Plate, Fig. C.

Shell small, subcircular to subpentagonal in outline, convex, longer than wide, with greatest width along the hinge-line; surface covered with a few prominent plications, in the largest forms generally eight in number, gradually decreasing in size toward the sides; wide, deep sinus generally occupies the median line, although an intercalated plication appears in some of the larger forms.

Ventral valve full; beak moderately high, somewhat attenuate; area linear, triangular, reflexed; foramen large.

Dorsal valve full, about two-thirds length of shell; septum prominent, but most of the brachial structure is destroyed.

The measurements of the specimens obtained show the length to vary from 1 mm. to 3 mm., and the width from .75 mm. to 2.25 mm.

The mature forms are more ventricose, with a somewhat greater width in the cardinal region, more elevated and curved beaks, and stronger plications upon the surface.

Cistella plicatilis, n. sp.

Plate, Fig. D.

Shell moderate sized, orbicular, slightly convex, longer than wide; surface with a considerable number of plications, ten or twelve on dorsal valve, together with a few short intercalated ones near the margin.

Dorsal valve slightly inflated; septum prominently developed.

The dimensions of the single specimen of the dorsal valve obtained are about 4.5 mm. both in length and width.

The species is quite distinct from *Cistella beecheri*.

Contributions to the Eocene Fauna of the Middle Atlantic Slope. By William B. Clark.

Attention has been directed to the Tertiary geology and paleontology of the Middle Atlantic slope since the very beginning of geological investigation in this country, and although the relations of the deposits were not altogether comprehended by the earlier geologists, yet the observations recorded show an appreciation of many of the more difficult problems involved. Even at a relatively early date an older and a younger Tertiary were recognized, the former, from the first, being correlated, with few exceptions, with the Eocene of England and the Continent of Europe, while attempts were even made to find its exact equivalent in one or another of the local formations of that portion of the world.

After the American Eocene strata had received detailed examination in the various sections of the country, and local divisions had been proposed, attempts were made to establish their equivalency. By common consent the diversified and extensive deposits of the Gulf area came to be regarded as the type for the eastern border region, and the various Eocene deposits of the Atlantic coast States were assigned to a position in this series, although very different limits were given by the various authorities. By some the Middle Atlantic coast deposits have been held to represent a single minor division, while others have regarded them as equivalent to a larger portion of the Gulf series. The latter conclusion seems to the writer, after consideration of both the paleontological and geological data, to be the only tenable position. In the past, too little attention has been given to the geological phenomena, while, at the same time, the knowledge of the fossils has been wholly insufficient for a proper interpretation of the faunal characteristics of the formation.

The Geological Criteria.—The lithological and stratigraphical characteristics of the Eocene in the Middle Atlantic slope afford some important criteria for the correlation of the strata. To begin with, the homogeneous nature of the deposits is a characteristic feature, indicating conditions throughout the period of Eocene deposition, undisturbed by important physical changes. Again, the fact that the strata are so largely made up of secondary materials shows that the position of accumulation was in the vicinity of a coast reached by no large rivers bearing sediment, while at the same time sufficiently removed from the coast line to be unaffected by shore conditions. It is further evident that these deposits, which are so largely glauconitic, were accumulated with exceeding slowness, as has been shown in the case of the formation of greensands upon the beds of existing seas.

Now when we compare these conditions of accumulation in the Middle Atlantic slope with the conditions that prevailed in the Gulf region, marked differences appear. In the latter area numerous rivers, draining the interior of the continent, discharged great quantities of material throughout Eocene time, making the deposits highly diversified. Instead of the green sands and greenish and black clays of the Middle Atlantic slope, which no longer to any large extent characterize the strata, are found coarser beds of sand and clay, often partly calcareous, which give every indication of rapid accumulation. To compare, therefore, the 150–200 feet of green sands and clays of the Middle Atlantic slope with one or two subdivisions of hardly equal thickness in the Gulf region would, even upon stratigraphical grounds without the aid of fossils, hardly be attempted. The strata of the Middle Atlantic slope must be represented in the Gulf by deposits many times their thickness.

The Paleontological Criteria.—When we come to a full examination of the faunal characteristics we find likewise that very different conclusions must be reached from those hitherto held. The few fossils collected up to the present time have come from a horizon low down in the formation, so that a very inaccurate idea of the fauna has been obtained. Scarcely 25 species were hitherto recognized with certainty, while nearly 125 have been obtained by the writer and those associated with him in this investigation. Although many of the species are apparently restricted to certain horizons, others range throughout the formation. Of those found more largely in the lower beds (which may be designated the *Aquia Creek Stage*), may be mentioned *Turritella mortoni, T. humerosa, Panopaea elongata, Cytherea ovata, Dosiniopsis lenticularis, Ostrea compressirostra*, representing a fauna decidedly "Lignitic" in character; while in the upper beds (which may be designated the *Woodstock Stage*), are found *Corbula nasuta, C. oniscus, Cytherea subimpressa,*

Protocardia virginiana, *Pecten rogersi* and other forms identical or closely related to "Claiborne" types.

I am, therefore, strongly of the opinion, upon both geological and paleontological grounds, that the Eocene deposits of the Middle Atlantic slope represent the greater portion of the Eocene series of the Gulf, its highest members alone excepted. Compared with the section recognized by Prof. E. A. Smith in the Alabama area it undoubtedly comprises the Lignitic, Buhrstone and Claiborne and, possibly, also portions of the White Limestone, although there is little paleontological evidence regarding the equivalency of the latter. Undoubtedly less change in faunal development would be produced under the stable conditions that prevailed in Eocene time in the Middle Atlantic slope than in the Gulf, so that the more highly developed fauna of the upper portion of the series in the latter area may have existed contemporaneously with older forms outside the region. Without a much fuller knowledge of the characteristics of the Eocene fauna in the intermediate district this cannot be definitely determined, although it seems highly probable.

I desire to recognize my obligations to the U. S. Geological Survey for the facilities afforded in the prosecution of this investigation as well as for the opportunity to publish the results under its auspices. The species referred to in the accompanying list have been largely figured, and the plates, together with fuller descriptions of the forms, will be found in the forthcoming government report.

I am also under great obligations to Professor E. D. Cope, Dr. W. H. Dall, Mr. T. W. Vaughan, and Dr. R. M. Bagg for important aid in the work.

DESCRIPTION OF SPECIES.

VERTEBRATA.

REPTILIA.

Thecachampsa marylandica, n. sp.

Tooth with elongate, slightly curved, conic crown; surface with fine, longitudinal striations. Less curved and elongate than *T. sericodon* Cope, but more coarsely striated.

Loc. Clifton Beach, Upper Marlboro, Md.

Euclastes (?), sp.

Fragments of costals, thin, smooth, and with rounded edges.

Loc. Clifton Beach, Md.

Trionyx virginiana, n. sp.

Fragments of costals with characteristic tuberculated surface; pits broad; ridges far apart and irregular.

Loc. Aquia Creek, Va.

PISCES.

Ischyrhiza (?) *radiata*, n. sp.

Caudal vertebra, with coalesced haemal and neural spines; two precaudal vertebrae elongate, deeply amphicoelous, with delicate neural spines.

Loc. Clifton Beach, Md.

Myliobatis copeanus, n. sp.

Upper dentition strongly arched; dental crowns distinctly striated. Lower dentition relatively flat; median teeth five times as broad as long; lateral teeth slightly longer than wide.

Loc. Clifton Beach, Md.; Aquia Creek, Va.

Carcharodon polgguras, Agassiz.

Loc. Evergreen, Potomac Creek, Va.

Lamna (?) *obliqua*, (Agassiz).

Loc. Aquia Creek, Front Royal, Evergreen, Va.

Oxyrhina hastalis, Agassiz.

Loc. Evergreen, Aquia Creek, Va.

Odontaspis elegans, (Agassiz).

Loc. Ft. Washington, Clifton Beach, Md.; Evergreen, Front Royal, Va.

Galeocerdo contortus, Gibbes.

Loc. Aquia Creek, Evergreen, Va.

ARTHROPODA.

CRUSTACEA.

Cythere, sp.

Numerous minute crustaceans of this genus were found.

Loc. Woodstock, Va.

MOLLUSCA.

CEPHALOPODA.

Nautilus, sp.

Fragments of the shell of an undetermined *Nautilus* are quite common.

Loc. Clifton Beach, Md.

GASTEROPODA.

Tornatella bella, Conrad.

Loc. Pamunkey Neck, Md.

Cylichna venusta, n. sp.

Shell ovate, rather globose; surface spirally striate; spire depressed; columella with small, obscure plait. Dimensions: length, 3 mm.; width, 2 mm.

Loc. Woodstock, Va.; Pope's Creek, Md.

Ringicula dalli, n. sp.

Shell five-whorled; surface of last four whorls strongly striate spirally; spire elevated, acuminate; outer lip much thickened and crenulate within; columella with thick callus and with two strong plaits. Dimensions: length, 3 mm., width, 1.5 mm.

Loc. Woodstock, Va.

Pleurotoma harrisi, n. sp.

Shell elongate, five or six whorled; surface with distinct, revolving lines of varying size, crossed by ridges; aperture narrow, with long, straight canal. Dimensions: length, 22 mm.; width, 7 mm.

Loc. Potomac Creek, Va.

Mangilia (*Pleurotomella*) *bellistriata*, n. sp.

Shell subfuniform, with short, pointed spire, five-whorled; surface with numerous alternating spiral threads, crossed by wavy lines and oblique ribs, the latter strongest at the shoulder. Dimensions: length, 25 mm.; width, 12 mm.

Loc. Pope's Creek, Md.

Volutilithes petrosa, Conrad.

Loc. Potomac Creek, Va.

Volutilithes (*Athleta*) *tuomeyi*, Conrad.

Loc. Potomac Creek, Va.

Volutilithes sp.

Loc. Aquia Creek, Va.

Caricella, sp.

Loc. Aquia Creek, Va.

Mitra marylandica, n. sp.

Shell rather thick, six-whorled (?); surface with numerous spiral threads, crossed by fine lines; spire moderately high; aperture elongate; columella nearly straight, with three plaits. Dimensions: length, 20.3 mm.; width, 7 mm.

Loc. Pamunkey Neck, Md.

Mitra, sp.

Loc. Pamunkey Neck, Md.

Pyropsis, sp.

Loc. Crownsville, Md.; Aquia Creek, Va.

Fusus (*Levifusus*) *trabeatus*, Conrad.

Loc. Popes Creek, Md.; Aquia Creek, Va.

Fusus (*Strepsidura*) *perlatus*, Conrad.

Loc. Aquia Creek, Va.

Fusus, sp.

Loc. Aquia Creek, Va.

Fulgur argutus, n. sp.

Shell four or five-whorled; later whorls with spinous tubercles at shoulder; body whorl also with two lower rows of tubercles, 10 to 14 in each row; canal rather long, narrow.

Loc. Potomac Creek, Va.; Pamunkey Neck, Md.

Calyptrophorus jacksoni, n. sp.

Shell large, solid, many whorled; spire prolonged, acuminate; surface of adult covered with thick, calcareous deposit, entirely enveloping the whorls; inner lip thickened with extensive callosity. Dimensions: length, 75 mm.; width, 30 mm.

Loc. South of Annapolis, Md.

Lunatia marglandica, Conrad.

Loc. Ft. Washington, Md.; Potomac Creek, Front Royal, Evergreen, Va.

Natica cliftonensis, n. sp.

Shell small, four or five whorled; spire low; body whorl much inflated; aperture large, with thick callus. Dimensions: length, 10 mm.; width, 12 mm.

Loc. Clifton Beach, Md.

Turritella mortoni, Conrad.

Loc. Ft. Washington, Upper Marlboro, Clifton Beach, Md.; Aquia Creek, City Point, Va.

Turritella humerosa, Conrad.

Loc. Ft. Washington, Clifton Beach, Md.; Aquia Creek, Va.

Calyptraea trochiformis, Lamarck.

Loc. Ft. Washington, Clifton Beach, Md.; Aquia Creek, Va.

Vermetus, sp.

Loc. Piscataway Creek, Md.; Aquia Creek, Va.

Scala virginiana, n. sp.

Shells, seven or eight whorled (?); varices, 15 to each whorl, inflected forward and prominent, crossed by numerous, uniform, fine spiral striae; aperture, nearly round. Dimensions: length of five whorls, 20 mm.; diameter largest whorl, 15 mm.

Loc. Aquia Creek, Va.

Solarium, sp.

Loc. Aqnia Creek, Va.

Gibbula glandula, (Conrad).

Loc. Potomac Creek, Va.

SCAPHOPODA.

Cudulus bellulus, n. sp.

Shell moderate size, polished, slightly arched; much contracted near the anterior extremity; anterior opening subcirenlar, posterior simple. Dimensions: length, about 10 mm.; width, 2 mm.

Loc. Woodstock, Hanoverville, Va.

PELECYPODA.

Teredo virginiana, n. sp.

Tube cylindrical, long, irregularly curved; surface smooth; prominent, transverse partition near posterior extremity.

Loc. Many places in Maryland and Virginia.

Gastrochaena, sp.

Loc. Aquia Creek, Va.; Upper Marlboro, Md.

Pholas (?) petrosa, Conrad.

Loc. Ft. Washington, Md.; Aquia Creek, Va.

Coralliophaga bryani, n. sp.

Shell transversely oblong, thin, slightly gaping posteriorly, prominent fold from umbo to lower margin; surface with delicate lines of growth and fine radial rows of minute granules, obsolete over much of the surface; teeth, two small cardinal and one long posterior lateral; pallial line with shallow sinus.

Loc. Pamunkey Neck, Md.

Solemya petricoloides (Lea).

Loc. Woodstock, Va.

Corbula nasuta, Conrad.

Loc. Woodstock, Va.

Corbula oniscus, Conrad.

Loc. Woodstock, Front Royal, Evergreen, Va.

Corbula aldrichi, Meyer.

Loc. Evergreen, Hanoverville, Front Royal, Va.

Tellina virginiana, n. sp.

Shell thin, posteriorly short, angular and slightly folded, anteriorly rounded and elongate; two small cardinal teeth and indistinct lateral teeth; pallial sinus obscure; surface with fine concentric lines. Dimensions: length, 15 mm.; height, 10 mm.

Loc. Hanoverville, Aquia Creek, Va.; Ft. Washington, Md.

Tellina williamsi, n. sp.

Shell small; surface with elevated, close set ridges or lamellae, increasing in size downward; posteriorly subangulated; two cardinal teeth, posterior bipid; lateral teeth strongly developed; pallial sinus deep. Dimensions: length, 8 mm.; width, 5 mm.

Loc. Potomac Creek, Va.

Cytherea ovata, Rogers.

Cytherea pyga, Conrad, and *C. liciata*, Conrad, are regarded as synonyms.

Loc. Ft. Washington, Glymont, Clifton Beach, Md.; Aquia Creek, Potomac Creek, Front Royal, Evergreen, Va.

Cytherea eversa, Conrad.

Loc. Hanover Co., Va.

Cytherea subimpressa, Conrad.

Loc. Pope's Creek, Md.; Woodstock, Hanoverville, Va.

Dosiniopsis lenticularis (Rogers).

Dosiniopsis meekii, Conrad, is simply a solid variety of Rogers' species.

Loc. Ft. Washington, Glymont, Clifton Beach, Md.; Aquia Creek, Potomac Creek, Va.

Panopaea elongata, Conrad.

Loc. Ft. Washington, Winchester, Md.; Aquia Creek, Va.

Pholadomya marylandica, Conrad.

Loc. Ft. Washington, Md.; Aquia Creek, Va.

Lucina aquiana, n. sp.

Shell somewhat compressed; surface with numerous concentric striae; lunules deeply incised; anteriorly elongate; posteriorly rounded; hinge with two cardinal and two lateral teeth. Dimensions: length, 18 mm.; height, 18 mm.

Loc. Aquia Creek, Va.

Lucina whitei, n. sp.

Shell small, globose; surface with prominent concentric lamellae, interrupted posteriorly by shallow fold; anterior side rounded; posterior angulated; margin crenulated. Dimensions: length, 4 mm.; height, 3.5 mm.

Loc. Woodstock, Hanoverville, Va.

Lucina uhleri, n. sp.

Shell small, orbicular; surface with numerous, uniform, elevated, concentric ridges; anterior and posterior sides rounded; interior with radiating striae; margin simple. Dimensions: length, 5 mm.; height, 4 mm.

Loc. Woodstock, Va.

Lucina dartoni, n. sp.

Shell small, suborbicular, thin; surface with fine distant, concentric lamellae, crossed by fine, irregular radial lines; anteriorly and posteriorly high-shouldered and angulated; lunules large; hinge area narrow; muscle impressions shallow; margin simple. Dimensions: length, 7 mm.; height, 5.5 mm.

Loc. Woodstock, Va.

Diplodonta hopkinsiensis, n. sp.

Shell small, suborbicular, globose; surface with fine, indistinct striations; anteriorly and posteriorly rounded. Dimensions: length, 9 mm.; height, 8 mm.

Loc. Evergreen, Va.

Astarte marylandica, n. sp.

Shell small, roundedly trigonal, somewhat compressed, thick, nearly equilateral; surface concentrically costated, with superimposed fine striae; umbones prominent. Dimensions: length, 16 mm.; height, 15 mm.

Loc. Upper Marlboro, Md.

Venericardia planicosta, Lamarck.

Under this species is placed *Venericardia ascia*, Rogers, and *V. regia*, Conrad.

Loc. Sassafras River, Severn River, South River, Ft. Washington, Pope's Creek, Md.; Aquia Creek, Potomac Creek, Woodstock, Front Royal, Evergreen, Va.

Protocardia virginiana, Conrad.

Loc. Pope's Creek, Md.; Woodstock, Va.

Crassatella alaeformis, Conrad.

Crassatella capri-cranium, Rogers, and *C. declivis*, Heilprin, are undoubtedly slight varietal forms of *C. alaeformis*.

Loc. Ft. Washington, Glymont, Clifton Beach, Md.; Aquia Creek, Potomac Creek, City Point, Va.

Crassatella aquiana, n. sp.

Shell moderately large, attenuated posteriorly; surface with few, broad, shallow, concentric furrows, and numerous fine concentric lines, often obscure; lunules broad, deeply depressed. Dimensions: length, 45 mm.; height, 35 mm.

Loc. Aqnia Creek, Va.

Nucula magnifica, Conrad.

Loc. Woodstock, Hanoverville, Va.

Leda parva, (Rogers).

Loc. Woodstock, Evergreen, Va.

Leda improcera, (Conrad).

Loc. Woodstock, Pamunkey River, Va.

Leda proterta, (Conrad).

Loc. Front Royal, Potomac Creek, Va.

Yoldia cultelliformis, (Rogers).

Loc. Pope's Creek, Md.; Woodstock, Evergreen, Va.

Pectunculus idoneus, Conrad.

Loc. Upper Marlboro, Md.; Woodstock, Va.

Cucullaea gigantea, Conrad.

Cucullaea onochela, Rogers, *C. transversa*, Rogers, and *C. idonea*, Conrad, are regarded as synonyms.

Loc. Severn River, Ft. Washington, Clifton Beach, Md.; Aquia Creek, Potomac Creek, Evergreen, Va.

Modiola potomacensis, n. sp.

Shell small, oblong, thin, tumid, anteriorly contracted; surface with fine costated striae, nearly obsolete anteriorly, crossed by irregular lines of growth; umbones prominent, curved. Length transversely, 14 mm.

Loc. Pope's Creek, Md.; Potomac Creek, Woodstock, Pamunkey river, Va.

Pecten rogersi, n. sp.

Shell small, orbicular, subpellucid, nearly equilateral, thin; surface shining, with fine, delicate, concentric lines, and rather obscure, radial ribs. Dimensions: length, 16 mm.; height, 18 mm.

Loc. Potomac Creek, Front Royal, Va.

Pecten johnsoni, n. sp.

Shell small, suborbicular, equilateral; surface with about 20 uniform distant, rounded costae, and a few short costae in interspaces near basal margin, the whole crossed by fine lines of growth. Dimensions: length, 14 mm.; height, 15 mm.

Loc. Potomac Creek, Va.

Pecten, sp.

Loc. Potomac Creek, Va.

Anomia mcgeei, n. sp.

Shell of left valve rather solid, convex, nearly equilateral; surface strongly lamellar, with faint radial plaits, stronger in the later than the earlier portions of the shell. Dimensions: length, 50 mm.; height, 48 mm.

Loc. Hanover Co., Va.

Ostrea compressirostra, Say.

Loc. Severn River, Crownsville, Ft. Washington, Glymont, Clifton Beach, Md.; Aquia Creek, Front Royal, Evergreen, Va.

Ostrea sellaeformis, Conrad.

Loc. Glymont, Md.; Aquia Creek, Potomac Creek, Hanoverville, Evergreen, Va.

Ostrea, sp.

Loc. Glymont, Md.; Aquia Creek, Va.

Ostrea, sp.

Loc. Clifton Beach, Md.; Aquia Creek, Va.

VERMES.

Serpula, sp.

Portions of Serpula tubes are common in many localities in Maryland and Virginia.

ECHINODERMATA.

ECHINOIDEA.

Fragments of species of a Diadematoid species from Potomac Creek and plates of a Spatangoid form from Evergreen, Va., were found, but generic determinations are not possible.

COELENTERATA.

By T. WAYLAND VAUGHAN.

ANTHOZOA.

Paracyathus (?) clarkeanus, n. sp.

Corrallum conical, usually slightly curved. Cross-section elliptical. Nearly always showing a distinct area of detachment, which is variable in size. Costæ not very prominent; forty-eight in number, corresponding to all the cycles of the septa; nearly equal in size, in young specimens those corresponding to the last cycle of septa are smaller than those earlier developed. No epitheca was observed, and is most probably absent. Septa thin, not projecting beyond the upper margin of the corallum wall, sides granulated; forty-eight in number, arranged in six systems of four cycles each; those of the first three cycles reach the columella; the fourth cycle fuse by their inner margins to the sides of the third cycle. Calicular fossa shallow. Pali apparently before all of the cycles of the septa except the last, small and thin, difficult to distinguish from the papillate upper surface of the columella. Rudimentary disseppiments apparently present. Columella fasicular; upper surface papillate.

The measurements of two specimens are:

Greater diameter of calice, - - - -	7 mm.	7.75 mm.
Lesser diameter of calice, - - - -	6 mm.	5.5 mm.
Height of corallum, - - - - -	12.5 mm.	9.75 mm.

Loc. Potomac Creek, Aquia Creek, Va.

Turbinolia acuticostata, n. sp.

Conical in shape as is usual in the genus, size small. Costæ tall and thin with irregular margins. Beginning with six, six more are soon developed, making twelve, between which in the intercostal furrows are double rows of perforations. From the base the twelve-costal condition exists for about one-sixteenth of an inch, when twelve more costæ are introduced. The costæ on the basal portion of the corallum are very slightly larger than they are on the upper portion; they are not so prominent on the basal portion as in *Turbinolia pharetra*. In the extreme upper portion twenty-four more small costæ are introduced, making the total number forty-eight, twice as many costæ as septa. In the intercostal furrows, after the development of the forty-eight costæ, there are only single rows of perforations; during the twenty-four costal stage there are double rows of alternating perforations in the intercostal furrows. The septa are twenty-four in number, in three cycles. Those of third cycle fuse, about half-way between the corallum wall and the columella, by their margins to the sides of the septa of the first cycle. Their sides are beset with distant sharp, small spines. All of the septa except those of the first cycle are thin and weak. Columella probably pillar like, without a star as in *T. pharetra*, but the specimens are too much broken to enable one to decide positively. Height, 6.5 mm.; diameter of calice, 3 mm.

Loc. Potomac Creek, Va.

Eupsammia elaborata, Conrad.

Loc. Aquia Creek, Potomac Creek, Va.

Eupsammia (?) pileolus, Conrad.

Loc. Kent Co., Va.

PROTOZOA.

By R. M. BAGG.

FORAMINIFERA.

Spiroplecta clarki, n. sp.

Test elongate, textulariform, finely arenaceous and firmly cemented; compressed strongly, lateral margins sharp and very slightly lobed; surface of shell rough, of a dull gray color; chambers at first planospiral then arranged biserially with nine or ten respectively upon each side; aperture, a median arched opening. Dimensions: length, 0.53 mm.; width, 0.2 mm.

Loc. Woodstock, Va.

Nodosaria affinis, d'Orbigny.

Loc. Woodstock, Va.

Nodosaria bacillum, Defrance.

Loc. Woodstock, Va.

Nodosaria communis, d'Orbigny.

Loc. Sunnyside, Md.

Nodosaria farcimen, (Soldani).

Loc. Pamunkey River, Va.

Vaginulina legumen, (Linné).

Loc. Sunnyside, Md.

Cristellaria radiata, Reuss.

Loc. Woodstock, Va.

Polymorphina amygdaloides, (Reuss).

Loc. Pamunkey River, Va.

Polymorphina austriaca, d'Orbigny.

Loc. Woodstock, Va.

Polymorphina communis, d'Orbigny.

Loc. Woodstock, Pamunkey River, Va.

Polymorphina complanata, d'Orbigny.

Loc. Pamunkey River, Va.

Polymorphina compressa, d'Orbigny.

Loc. Woodstock, Va.

Polymorphina elegantissima, Parker and Jones.

Loc. Woodstock, Va.

Polymorphina gibba, d'Orbigny.

Loc. Woodstock, Va.

Polymorphina praelonga, Terquem.

Loc. Woodstock, Va.

Globigerina bulloides, d'Orbigny.

Loc. Woodstock, Va.

Discorbina bertheloti, d'Orbigny.

Loc. Woodstock, Va.

Truncatulina lobatula, (Walker and Jacob).

Loc. Woodstock, Va.

Pulvinulina elegans, (d'Orbigny).

Loc. Pamunkey River, Va.

Pulvinulina schreibersii, (d'Orbigny).

Loc. Woodstock, Va.

Nonionina affinis, Reuss.

Loc. Woodstock, Va.

Nonionina depressula, (Walker and Jacob).

Loc. Pamunkey River, Va.

Amphistegina lessonii, d'Orbigny.

Loc. Woodstock, Va.

A few specific names are omitted from the list of Eocene forms reported from the Middle Atlantic slope either on account of the fragmentary nature of the types, as in the case of *Crassatella palmula*, Conrad, and *Nucula parilis*, Conrad, or lack of any description, as in *Ostrea subcversa*, or finally on account of derivation from another formation, as in *Anomia ruffini*, Conrad, which is undoubtedly a Miocene species.

Additional Observations upon the Miocene (Chesapeake) Deposits of New Jersey. By WILLIAM B. CLARK.

The occurrence of extensive deposits of Miocene age throughout eastern New Jersey was first described by the writer in the Annual Report of the State Geologist for 1892, and again in the Report for 1893, when the identity of the strata with the Chesapeake formation farther south was claimed. A later paper was presented at the Baltimore Meeting of the Geological Society of America in December, 1894, in which the marginal features of the formation were described.

Although some of the earlier reports of the State Survey and a few special articles contain references to the pre-Pleistocene age of a portion of these beds, it is evident that the stratigraphical relations of the deposits were not understood, while little attempt was made to indicate their areal extent.

As the result of detailed mapping on the part of the writer and his assistants however, it has been possible to satisfactorily determine the relations of the Miocene strata throughout the State, and to prove the identity of the gravels, sands and clays in the northern portion of the area, with the sands, clays and fossiliferous marls in the southern, while the examination of the intervening region has shown the direct continuation of these deposits into the already described Chesapeake formation of the Middle Atlantic slope.

In his exhaustive studies of the late Tertiary and Pleistocene of New Jersey, Professor Salisbury has recently employed the name "Beacon Hill formation" for the gravels and sands occurring in the northern portions of the district. These together with the clays and marls associated with them have been traced as above mentioned into the Chesapeake strata farther south.

Areal occurrence and relations.—The Miocene strata of New Jersey extend as a broad belt northeast to southwest across the State to the southeast of the greensand formations, while numerous isolated areas are found here and there scattered over those deposits throughout or adjacent to the Highland range. In a few instances the strata extend quite to the western limit of the coastal plain.

In the northeast the Miocene reaches sea level near Asbury Park, but to the southwest, on account of the extensive covering of post-Miocene deposits in the Delaware drainage, the line is obscured and removed some distance inland. In passing northwestward the deposits reach constantly higher elevations, conforming in a general way to the gradual easterly dip of the greensand marls. On the northern flanks of the Hominy Hills, which form the northwestern edge of the main sheet, the strata reach an elevation of about 100 feet at their basal margin, while small patches to the northeast of Freehold fall little short of 200 feet. Just above Atlantic Highlands the contact reaches nearly 240 feet, while in the Beacon Hill area it slightly exceeds 350 feet. Farther to the southward, near the boundary of Monmouth and Ocean Counties, the main body of the Miocene reaches an elevation of 200 feet at the contact, while in the outliers of the Pine Hill region the lines rise to about 300 feet. Ten miles farther to the southward the western margin of the main sheet declines to very nearly 100 feet, although rising in a detached area a few miles to the north of Arneytown to about 210 feet. Thence southward the elevation of the western margin of the main sheet continues to decline until in the region to the east of Vincentown the base stands at scarcely 50 feet. Few large outliers are found throughout this area, although the Miocene caps the summit of Arney's Mount with a minimum elevation of about 115 feet, Mount Holly 150 feet, Mount Laurel 140 feet. In the vicinity of the Camden and Atlantic railroad the marginal contact falls below 100 feet. At Mullica Hill the base stands at about 110 feet, but the main body of the formation farther east falls considerably below that elevation. The margin of the formation continues to decline southwestward and to the east of Salem is scarcely 50 feet, while only a few detached areas occur.

Although resting with but a slight unconformity upon the beds beneath, the Miocene nevertheless successively overlies older formations to the northwestward, passing from the Shark River formation near Asbury Park and Shark River to the Manasquan formation near Deal, Farmingdale, Pemberton and Medford and reaching the Rancocas formation in the vicinity of Long Branch, Fairfield, New Egypt and Mullica Hill, while resting upon its lower portions in the detached areas of the Navesink Highlands, Mount Pleasant Hills and Pine Hill district as well as along the margin of the main outcrop throughout much of the southern portion of the State.

Throughout the greater part of the central and northern district the Miocene is the surface formation, except at the lower levels where the Lafayette and Columbia formations now conceal it. The high lands of the Hominy Hills, Mount Pleasant Hills, Pine Hill, Arney's Mount, Mount Laurel, etc., were probably not depressed during the subsequent Lafayette or Columbia submergences to a sufficiently low level to receive any sediments upon their summits and undoubtedly existed as islands in the post-Miocene seas. In the southern district the Lafayette formation rests upon the Miocene almost everywhere and is in turn generally overlain by the Columbia.

As the Lafayette and Columbia unconformably overlie the Chesapeake and nowhere reach any great thickness, that formation is frequently exposed far to the eastward as the result of denudation. Outcrops occur at many points beyond the New Jersey Southern railroad, notable exposures being found in the south in the vicinity of Hammonton and Millville.

The stratigraphy of the later formations and their relations to the Miocene have been fully investigated by Professor Salisbury, and as an account of them will shortly appear, the subject will not be further dwelt upon here.

Lithological Character and Thickness.—The Miocene deposits consist of gravels, sands, clays and fossiliferous marls.

The gravels are confined very largely to the northern part of the region, although not entirely absent from the southern districts. They are more largely developed also in the outliers and in the marginal portions in the west, than to the eastward. The gravels are very variable in texture, often consisting of extensive deposits of uniform, well rounded pebbles, while at other times of a heterogeneous mixture of coarse and fine materials which in some instances contain boulders 10 or 12 inches in diameter. The gravels are largely composed of quartz, sandstone, and quartzite. They are well exhibited in the northern portion of the Highland range and in the Hominy Hills.

The gravel is commonly inter-stratified with beds of coarse and fine sand, the latter becoming more and more pronounced to the southward. The coarse sands are characterized by great quantities of angular quartz grains which also occur at times in the finer. The latter, however, are more often homogeneous, of a characteristic buff or snuff color, very fluffy and indistinctly stratified. The sands show a great variety of materials, although mainly quartzose, quartz and chert predominating. Fragments of silicified Palaeozoic fossils are also not uncommon. In the region to the south of Long Branch the worked over greensand becomes a conspicuous element, and caused much confusion in the classification of the older geologists. Both the sands and the gravels are at times highly ferruginous and may become cemented into a compact sandstone or conglomerate. On the other hand when thoroughly weathered the iron may be almost wholly removed and the surface materials may then become of dazzling whiteness. The sands form the main body of the formation, especially in its upper portions. They extend all the way across the State in one or another of their characteristic phases.

The clays are commonly micaceous and often arenaceous, although in some localities, particularly in the south, they become highly plastic. They are generally dark colored as the result of the carbonaceous matter which they contain, and often show a tendency to part along the bedding planes, especially in the more micaceous and arenaceous varieties. A fact described by Cook, and frequently observed by the writer, is the astringent characte of the clays at many points, particularly in the south. Although the clays are commonly distinct from the sands and underlie them, there are some localities where the clay is clearly interstratified with the sand or rests upon it, as near Centerville, Shark River, and Ewans Mills, while in the deep borings at Atlantic City this relationship is even more strikingly displayed.

The fossiliferous marls so far as observed are only exposed at the surface in the southern portion of the State along the upper branches of Stow Creek, not far from Shiloh and Jerico, where a series of clay beds, the lower filled with great numbers of molluscan shells is interstratified with the characteristic sands of the Miocene. On account of the covering of post-Miocene materials the fossiliferous beds have not been as yet traced far from the localities above mentioned.

The thickness of the formation cannot be readily determined as there are no satisfactory sections along which measurements can be made. The deep well-borings at Atlantic City, and other points, indicate that the formation cannot be less than 500 feet, and it may be considerably greater. Regarding the dip of the strata at about 20 feet in the mile, and that is a low estimate, a somewhat greater thickness than 400 feet would be obtained by connecting the outcrops. In the Hominy Hills, which are composed chiefly of the gravels and sands, the strata are 200 feet thick, but in none of the outliers of the Highland range does the thickness much exceed 100 feet, while in the greater number of instances only thin remnants of the deposits are found. A careful study of later well-borings can alone determine the matter.

Correlation of the deposits.—The writer has insisted, from the very beginning of his investigations in the New Jersey area, upon the Miocene age of the greater part of the strata above described, and at no time has regarded them other than the equivalent of the Chesapeake formation of the Middle Atlantic slope. As the detailed mapping of the deposits has proceeded and the strata in the northern and southern portions of the State, as well as in Delaware and Maryland, have been connected step by step, the determination of this equivalency has been proved beyond all question.

Although fossils are not found widely through the strata, those which have been obtained indicate that the New Jersey deposits belong to the Chesapeake formation, the species, however, being mainly characteristic of its lower members. Some of the forms are regarded by Dall as indicative of the older warm water Miocene of the south, but as the basal beds of the Chesapeake formation in Maryland and Virginia have never been fully investigated they may afford similar forms.

Deformation.—The elevations given for the basal plane of the Chesapeake formation show that it has been subjected to very clearly defined deformation in conjunction with the formations which underlie it. The average dip of the formation, which is between 20 and 25 feet in the mile toward the south-east, indicates an elevation and deformation of the beds to a corresponding extent. This change has not been uniform throughout the

region, but considerably greater in the north than in the south, the difference along the strike exceeding 100 feet in the distance between the Camden and Atlantic railroad and the Navesink Highland, or about 150 feet for the whole length of the State. At the same time the beds have been considerably depressed along their western margin, the chief axis of folding corresponding very nearly to the highlands forming the eastern and western water-shed.

Notes on some Flattened Garnets from North Carolina. By Edward B. Mathews.

Through the kindness of Mr. Geo. F. Kunz the writer has had an opportunity to study some curiously flattened garnets which had been collected by Mr. Kunz during one of his trips to the mineral localities of North Carolina. The locality whence these garnets come and the exact geological occurrence were not given, but we know that they are found as an accessory constituent of the pegmatite dykes and that they are intimately associated with the mica between lamellae of which they were developed.

This inauspicious habitat has caused a marked distortion of the crystals during their growth, and we have as a result small plates of garnet substance in which the diameter of the larger faces is from 10 to 50 times that normal to those faces.

From a consideration of its color, its place of occurrence, and especially its specific gravity which ranges from 4.199 to 4.258 it is probable that this is a member of the spessartine group.

When the crystals were studied goniometrically[1] it became evident that the forms present are those ordinarily developed; the rhombic dodecahedron $\infty 0$ and the icositetrahedron 202. Some of the faces belonging to these forms are usually absent but the characteristic angles are so frequently noted that there is little doubt as to the correctness of determination. It is found that the larger, flatter faces are of two sorts: the perfect ones $//\infty 0$ and the vicinal, curved ones produced by the oscillatory combination of such faces and the adjoining faces of the icositetrahedron. This oscillatory combination of two forms does not give an irregular serrated surface, as is seen frequently in quartz and other minerals, but, instead, we seem to have a curved face of small convexity which has a perfectly smooth surface, probably produced through the influence of the smooth mica lamellae as they were pushed apart.

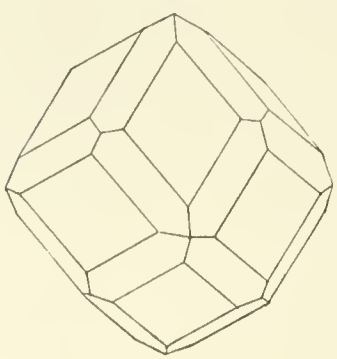

Fig. 1.

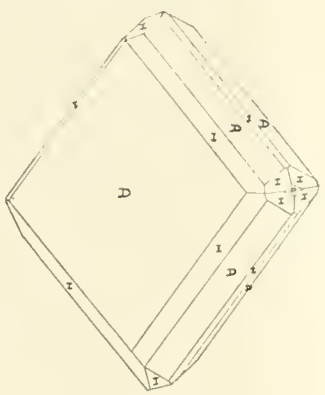

Fig. 2.

Fig. 1 shows the two forms $\infty 0$ and 202 in the normal development, while Fig. 2 shows the modifications as found in the garnets. On the edge of the crystal we find the characteristic grouping of the icositetrahedral faces about the diamond shaped dodecahedral face, the only difference arising from their elongation in a single direction (a feature developed in the faces of both forms whenever their zonal axes lie parallel to the broader faces.

Optically, also, these crystals show interesting phenomena as might be expected from their unusual habit. The crystals are of a rich reddish brown to carmine color in incident light, and of the same in lighter tones when viewed in transmitted light. The centres are usually darker and, with the slight variations of color along the lines of growth, give the appearance macroscopically of a section of a minute tree. Microscopically this black centre is seen to be composed, for the most part, of small pores and a few liquid or gaseous inclusions which frequently show some arrangement parallel to the crystal faces or the plane of the diagonals connecting their edges. A few of these inclusions influence polarized light and may be individualized though indeterminate minerals.

In size the clearest and thinnest individuals range from $\frac{1}{2}$–$\frac{1}{4}$ cm. by 1–2 mm. The darker centres range in width from one-eighth to seven-eighths of the diameter, the darkest portions always remaining towards the interior, the lighter forming an outer rim.

In order to study the anisotropism of these garnets[1] they were immersed in a dilute solution of methylene iodide to counterbalance the high index of refraction. The cross-polarized light showed that the outer zone is doubly refracting, though but feebly.

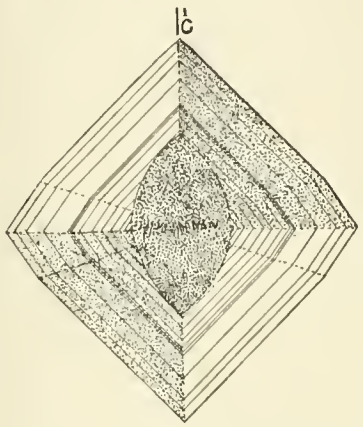

Fig. 3.

With the aid of the gypsum plate the effect of the double refraction was increased and the following features were noted:—

1. The outer rim is made up of a series of zones of growth varying in size and frequency.

2. These zones or lamellae of growth are parallel to the exterior faces. In this particular instance, from the modification due to flattening, the area of growth is a fibre or prism whose long axis is parallel to the crystallographic edge of the rhombic dodecahedron, while the shorter axes are parallel to the octahedral edge and crystallographic c.

3. The whole crystal breaks up into four sections whose dividing lines pass inward towards the corners of the interior isotropic core (see Fig. 3), *i. e.*, parallel to the octahedral edges.

4. The directions of elasticity in the lamellae are parallel and normal to the longer directions, as is seen by the extinction parallel to the faces of growth.

5. These lamellae are negative, their longer directions being the direction of less elasticity as shown by the mica plate.

6. The mineral lamellae seem to be biaxial, if we may judge from the wavy character of the brush shown by the broader zones in converged light.

The above facts may be explained by various sorts of optical orientation and, though no direct proof can be given, the writer is inclined to consider the orientation to be: German b parallel to the dodecahedral edge, German a to the octahedral edge, and German c normal to these two and approximately normal to the plane of flattening.

All the features observed seem to show that the optical anomalies are the result of irregularities in growth, as held by Klein and his followers; and are not due to irregularities in pressure arising from the external conditions. The circumstances of the growth produced an accentuation of the zonal growth and so indirectly increased the anisotropism, but from the facts at hand we are not justified in asserting that there is any direct increase in the double refraction on account of the flattening of the crystals.

A Contribution to the Neocene Corals of the United States. By Henry Stewart Gane.

The present paper is intended merely as a preliminary notice of the Neocene Corals of this country, a more comprehensive treatise being in course of preparation. At this time some of the general results of geological interest will be given, together with a revision in nomenclature of the forms previously described, as well as a brief description of a few new species.

The material treated in this paper is lent to the writer from the collections of the U. S. National Museum and Wagner Free Institute of

[1] The writer is indebted to Mr. A. C. Spencer for his careful study of the forms present on the crystals.

[1] The garnets were so thin that it was not necessary to cut sections.

Science, through the courtesy of Dr. Wm. H. Dall and Mr. Joseph Willcox, respectively, as well as from the Philadelphia Academy of Natural Sciences, the private cabinet of Mr. Joseph Willcox of Philadelphia, and the Johns Hopkins University.

The state of preservation of the corals is, as a rule, excellent, with the exception of the silicified forms from Florida. The latter are often very difficult of determination owing to prefossil wear, and the mineralogical change the specimens have since undergone.

The fauna under discussion embraces, in its geological distribution, the Neocene period, including both the Pliocene and Miocene epochs, the latter being represented by specimens from both its lower and upper or warm and cold water facies. On the other hand, geographically the range of these forms is remarkably confined. With the single exception of a few casts from the Miocene of Griswoldville, Fresno Co., Cal., we find them limited to the Atlantic seaboard states, from New Jersey to Florida.

In considering the fauna as a unit, its most striking feature is the number and variety of the genera represented, as compared with the species.

In examining the bathymetric distribution of the species it is doubtful whether any truly deep-sea forms are represented. The few genera, that might be so classed, are also frequently found living in shallow depths. When we add to the above the fact that they occur in the deposits side by side with true reef-builders, we may consider that the corals of the Neocene flourished as shallow-water forms with preponderating reef-building tendencies.

The assertion has been made that it is possible to judge of the similarity or of the variation of the physical conditions of a region not only by the genera and species represented, but by the relations which the forms of one portion of the district bear to those of another. If this be true then the conditions prevailing upon the Atlantic coast during Neocene time were most varied, both from a geological and geographical standpoint; for we find in this fauna that the genera of corals are quite varied, and that the individual species are very limited both vertically and horizontally in their stratigraphic distribution. In this distribution the Pliocene species are perhaps more liable to be limited in their geographical range than in their geological, since a number of the forms are either found as recent or having closely related living allies, whereas the Miocene species appear to be about equally confined both from a geographical and geological aspect.

A majority of the corals represented belong to extinct species. A few are now found living in the Caribbean Sea and Atlantic Ocean, and some are identical with or belong to closely allied fossil forms from San Domingo and other West Indian Islands.

We should expect that the Neocene corals of the United States would have a close kinship with those of like age in the West Indies, but such does not seem to be generally the case. This agrees with the theory of Professor P. M. Duncan who considered, that the fossil Miocene corals of the West Indies are most closely related to those of the Miocene of Europe and the recent fauna of the Pacific and Indian Oceans. Regarding the affinities of the Neocene fauna of the United States as a whole, we come to the conclusion that it has more of a likeness to that at present living in the Caribbean Sea and Atlantic Ocean than to the fauna recent or fossil of any other region.

Description of Species.

Desmophyllum willcoxi, n. sp.

Corallum quite variable in shape, more or less compressed, conical, attached at base by a moderately long pedicle, which may be either broad or narrow. Surface of wall and costal ridges smooth, at times showing the development of an epitheca. Summits of the calice on the shorter diameter higher than on the longer. Margin of the calice irregularly dentate. Interior of the wall coarsely pitted here and there between the septa. Six systems of septa with four well developed cycles, and a fifth rudimentary septum exist, rather stout, thicker near the wall and in the vicinity of the base of the calicular fossa, generally straight but often curved, with granulated sides. In well preserved specimens the fossa is deep and narrow, and the free margins of the septa at the base of the fossa often form by means of small rod-like projections, a sort of columella as in Flabellum.

Dimensions of largest specimen are: height, 28 millimeters; greatest length and least width of calice, respectively 32 and 25 millimeters. The calices of the majority of the specimens are, however, more compressed than in this one.

Geological Horizon. Miocene.

Localities. Ballast Point, Tampa Bay, Florida.

Paracyathus vaughani, n. sp.

Corallum small, broad and low, with the calice about the same diameter as the base, above which the wall is somewhat constricted. Wall thin, costulate to its base. Costae unequal, finely granular, much more prominent near the calicular margin where they are considerably thicker than their corresponding septa. Calice circular in the young, slightly oval in the adult individual; fossa broad, moderately deep. Septa in six systems of five cycles lacking part of the sixth order of the last cycle; in forms of medium size but four cycles are present. Primaries and secondaries subequal, thick and stout, with summits more broadly rounded and more strongly exsert than those of the remaining thin and slender septa; sides coarsely granulated, edges dentate. Pali granular, present before all the septa but those of the last cycle, excepting in the most mature forms where they may be lacking before a part of the fourth as well as before all of the fifth cycle of septa. Columella papillose, well developed.

Height of largest specimen 4 millimeters, breadth of calice 11 millimeters.

Geological Horizon. Miocene, Chesapeake formation.

Localities. Carter's Landing, James River and Yorktown, Virginia.

Astrohelia palmata, (Goldfuss).

Originally described by Goldfuss as a *Madrepora*, but made the type of the genus *Astrohelia* by Edwards and Haime.

Geological Horizon. Miocene, Chesapeake formation.

Localities. Shiloh, New Jersey, and common at many localities in Maryland.

Antillia biloba, (Duchassaing).

This specimen was originally described as *Turbinolia biloba*, but in 1864 it was first considered to be an *Antillia*. When comparing this coral at different stages in its growth, it is very variable in shape. Had either of several extreme types occurred alone without connecting forms, it might well be considered as a distinct species. The young are but slightly, if at all, bilobed, the most mature individuals alone being turbinate and vertically constricted with a figure-eight-shaped calice, the latter characteristics being described by Professor Duncan as typical of the West Indian forms.

Geological Horizon. Miocene, Chipola formation.

Localities. Bailey's Ferry, Chipola River, Calhoun County, Florida; San Domingo, Guadeloupe (fossil horizon not given), W. I.

Astrangia lineata, (Conrad).

This form was considered a *Lithodendron* by Conrad and an *Anthophyllum* by Lonsdale, both of which writers early described it. Later it has been referred to several other genera, but the present writer considers it a true *Astrangia*, although there is perhaps more of an epitheca present than has been hitherto considered as characteristic of the genus. In all other respects this species seems to be typical.

Geological Horizon. Miocene, Chesapeake formation.

Localities. Bellefield, Yorktown, Carter's Landing and City Point, Virginia.

Astrangia astraeiformis, Edwards and Haime.

This species is found recent on the shores of the Atlantic from North Carolina to Florida. It is closely related to *Astrangia danae*, Ag., occurring on the coast of this country from New Jersey to Massachusetts. In many respects it also resembles the fossil *Astrangia lineata* from the Virginia Miocene.

Geological Horizon. Miocene.

Locality. Cain Hoy, South Carolina.

Cœnangia bella, (Conrad).

This species was first described as *Astrea bella* by Conrad, but later referred by Professor Verrill to the genus *Astrangia*, subgenus *Cœnangia*.

Geological Horizon. Miocene, Chesapeake formation; and Pliocene? of Tuomey and Holmes.

Localities. Darlington, S. Carolina; Newburn, N. Carolina; Prince George County, Virginia.

Cœnangia marylandica, (Conrad).

This species was first described by Conrad as *Astrea marylandica*, but later referred by Professor Verrill to the subgenus *Cœnangia*.

Geological Horizon. Miocene, Chesapeake formation; and Pleiocene? of Tuomey and Holmes.

Localities. Virginia and South Carolina.

Phyllangia floridana, n. sp.

Colony incrusting, consisting of subturbinate corallites arising from the basal expansion. Individuals generally free above but somewhat closely united at their bases. Walls thin at the calicular edge, thicker below. Costae minutely granulated, low, subequal, reaching to the base, but more prominent at the calicular margin and at the swellings just beneath the constrictions in the walls of the corallites. About on a level with the bottom of the fossa, the diameter of the corallite is least, the walls being here somewhat constricted, beneath which constriction they are again frequently swelled to a diameter equal to that at the calicular margin. Calices somewhat expanded, widely open, deep, narrow at the bottom. Septa crowded, in six systems of four complete cycles, lacking a few septa of the fifth order; primaries and secondaries more exsert, thicker and broader than the septa of the following cycles, quarternaries least exsert, thinnest and narrowest; sides of the septa sharply granulated, and the edges of all but the fourth cycle rounded superiorly and subentire in their upper parts, the lower two-thirds of the septal edges being strongly lobate or dentate, the uppermost tooth being the most prominent and similar in shape to a true paliform lobe. Columella papillary, occupying a very limited area; the time of separation between the papillae of the columella and the lowest teeth of the septa being indistinguishable. Germination by budding from the basal expansion of the wall of a parent corallite.

This form in its general size and mode of growth very much resembles the *Astrangia lineata*, (Conrad), of the Virginia Miocene deposits.

Breadth of calice from 4 to 6 millimeters.

Geological Horizon. Pliocene, Caloosahatchie beds.

Locality. Alligator Creek, Monroe County, Florida.

Cladocora johnsoni, n. sp.

Corallites slender, somewhat flexuous, and cylindrical. When found fossil they are detached from the parent colony. Walls of moderate thickness. Costae granular, well developed and close set, the larger corresponding in position to the septa of similar development. With the exception of a few costae of the fourth cycle, all reach to the base of the corallite. Calices circular with a shallow fossa. There are six systems of three complete cycles, with occasionally a few rudimentary septa of an incompleted order of a fourth cycle. Septa exsert, the primaries more prominently so, rounded and very finely granulated laterally, giving the laminae a slightly striated appearance; primaries thicker and broader than secondaries, which in turn have a similar relation to the tertiaries. Either true pali or paliform lobes are present before all but the last cycle of septa. Columella coarsely papillary, but rather narrow. Germination lateral and often in pairs at the same height on the stem.

Height of largest specimen 12 millimeters; breadth of calice from 2 to 2.8 millimeters.

Geological Horizon. Pliocene.

Locality. Waccamaw River, South Carolina.

Manicina pliocenica, n. sp.

This species is identical with the *Manicina areolata* of Linnaeus except in the following particulars. It differs in that its collines are generally broader; the septo-costae of adjoining individuals are not commonly united, the walls of the individuals being distinct. Septa somewhat stouter and less crowded together, only in rare cases exceeding eleven in number to the centimeter; the teeth on the inner edge of the septa are more regular in size and shape. On the other hand, in *Manicina areolata* the collines are rather narrow, with many of the septo-costae of neighboring individuals united. The septa are thinner and more crowded, from fifteen to twenty (Quelch) to the centimeter. The teeth on the inner edge vary more in different parts of the same septum.

Geological Horizon. Pliocene.

Locality. Caloosahatchie River, Florida.

Septastraea serradinta, (Lonsdale).

The writer considers the *Septastraea Forbesi*, E. and H., to be a synonym of the above. As the discussion of this point is a long and complicated one, it will be left to a future date.

Geological Horizon. Miocene, Chesapeake formation.

Localities. Bellefield and Yorktown on the York River, and at many points on the James River, Virginia.

The Spotted Slates associated with the Sioux Quartzite. By S. W. Beyer.

The Sioux quartzite is typically exposed along the principal streams in Minnehaha County, South Dakota. In the north-east corner of the County, Split Rock Creek has cut a deep cañon through this refractory formation, exhibiting a magnificent natural section which is known as "The Palisades." At this point the quartzite has a south-westerly dip varying from 3–7° and grades upward into a reddish slate which has been largely eroded, occurring only in detached areas. Tracing the outcrops to the south-west, the slates become more prominent and the color deepens to a purplish black. The formation finally disappears under the drift in section 15, township 103 N, range 47 W.

As has been mentioned, the slates are variable in color and weather to a light gray or pinkish gray. True slaty cleavage is absent, but parting may be readily effected along the bedding plane. These are not true slates in the ordinary acceptance of the term, but correspond very closely to the quartz-slate of Irving and Van Hise.[1] Their specific gravity varies from an average of 2.65 for the dark colored members to 2.83 for the deep red, ferruginous variety at the Palisades. They vary in texture from the extremely fine grained, homogeneous "pipestone" to arenaceous slates or argillaceous quartzites. At the Palisades the slates are interbedded with the quartzite, and there are insensible transitions from the pipestone to a vitreous quartzite.

Microscopically considered, they are composed essentially of quartz, a micaceous mineral, the iron ores and more or less carbonaceous material. They differ from the quartzite, in that the quartz grains are smaller and more angular, and by the presence of a large amount of argillaceous material, which has crystallized to a considerable extent, as sericite or kaolin, or, in some instances, chlorite; and in the increased percentage of iron. The angularity of the quartz grains seems to vary inversely as their size; hence, in general, the smaller the grains, the sharper are their angles. When the amount of interstitial material is relatively great, the grains seldom have definite boundaries but seem to fade out at the edges, and often the peripheral portion of the grains is charged with very finely divided particles of iron oxide and carbonaceous material. This rim is undoubtedly of secondary growth.

[1] The Penokee Iron-bearing Series, 10th Ann., U. S. G. S., p. 370, 1890.

The slates over the whole district present peculiar markings in the form of circular spots, which, seen in three dimensions are spheroidal, with the major axis parallel to the bedding plane, and show extremely sharp contours. These spots vary from a centimeter in diameter down to mere specks. They are always of lighter color than their matrix and commonly show concentric arrangement of color, alternately yellowish gray and pink shells. This alternation is rarely repeated more than three times; generally gray pink, and gray center; while in the smaller spots, there may be but a single alternation. The matrix in immediate contact with the spot, is usually of a deeper hue than the mass of the rock and thus tends to heighten the contrast. As to disposition of the spots, there seems to be no law controling their arrangement. They sometimes occur along joint and bedding planes, but are quite as common removed from both.

Microscopically, the spots are essentially the same as their matrix, save that they contain less of the iron constituent and seemingly more of the micaceous mineral, which probably owes its increased prominence to the increase in transparency due to loss in iron. That the difference in color does not arise from the change in the state of combination, but upon the withdrawal of the iron constituent, has been proved by numerous chemical analyses of related occurrences. Maw,[1] in his studies "On the Disposition of Iron in Variegated Strata," carefully separated the material composing the light colored spots from their deeply colored matrices in sandstones, shales and slates, and demonstrated by an elaborate series of chemical analyses, that the bleaching is due to the removal of the iron.

The general appearance of the spots, both macroscopically and microscopically, is almost, if not wholly, identical with the decolorized areas along joints and on exposed surfaces, whose present state can be definitely referred to the action of weathering agencies. In both cases the resultant product owes its origin to the removal of the iron constituent; but the anomalous arrangement of the spots and their entire independence of joints, fractures and bedding planes, precludes their reference to any external agency. The active principle in the leaching process must have originated within themselves. Iron as a coloring agent in rocks is generally in the form of the insoluble ferric oxide (sesquioxide), and according to Dawson,[2] the leaching process is inaugurated by the reduction of the sesquioxide, by the action of organic matter, to the soluble protoxide, which is then readily removed by the percolating waters. The verity of this process has been confirmed by many observers, and has come to be a recognized principle in the theory of bog iron ore accumulation. Diligent search was made for any trace of organic remains in the spots under consideration, but without success; yet no other explanation of their origin appears tenable.

The Cretaceous Foraminifera of New Jersey. By R. M. Bagg.

The present article is a brief outline of the results obtained from a study of the Cretaceous Foraminifera of New Jersey, the full report upon which will shortly appear in monograph form. The material was collected by the writer from the following formations:

Navesink formation, (lower marl bed), at Freehold, Atlantic Highlands, and Cream Ridge.

Rancocas formation, (middle marl bed), at Vincentown, Blue Ball, New Egypt, Quinton, Swedesboro, Timber Creek, and Harrisonville.

Manasquan formation, (upper marl bed), at Vincentown.

It was hoped that a careful study of the Foraminifera found in these various marl beds might not only result in the addition of many species to our American Cretaceous, but might also serve as a method of determination of these strata. Such has been found to be the case in many instances, although the persistence of certain forms through all the beds is established, while many of these have been found in later deposits and in present oceans. The excellent state of preservation of these Foraminifera, together with the enormous size of some of the species, is most striking and bears witness of the favorable conditions for their existence in the late Cretaceous sea.

Although the occurrence of Foraminifera in the Cretaceous marl beds of New Jersey was noted early in the present century, only two papers of

[1] Quar. Jour. Geol. Soc., Vol. XXIV, pp. 351–400, 1868.

[2] Quar. Jour. Geol. Soc., Vol. V, p. 25, 1848.

any value have as yet been published. The first paper was written by one of the most distinguished European paleontologists, Prof. A. E. Reuss,[1] in 1861, and contains a description of some twenty-eight species, although no localities are given nor the horizon from which these forms were obtained. The second article is by Dr. Anthony Woodward,[2] and was published in the *Journal of the New York Microscopical Society* in two parts. The first portion of this work, published in 1890, contains only a review of previous publications upon the Cretaceous Foraminifera of New Jersey. In the second part, published in 1894, some fifty-eight species of Foraminifera from Timber Creek, Mullica Hill, New Egypt, and Bruere's pits on Crosswick's Creek, are described but not figured. This report is the most satisfactory which has yet been published.

The material investigated at the Johns Hopkins University has furnished nearly twice as many species as previously reported, and it is quite certain that more extended study cannot fail to yield additional results.

Acknowledgments are especially due to Professor W. B. Clark under whose direction this investigation has been carried on.

The following is a list of species identified:

DESCRIPTION OF SPECIES.

1. *Anomalina ammonoides*, (Reuss). Freehold, Bruere's pits, Vincentown, New Egypt, Timber Creek, etc.

2. *Anomalina grosserugosa*, (Gümbel). Swedesboro, Vincentown.

3. *Bolivina punctata*, d'Orbigny. Freehold, Bruere's pits.

4. *Bulimina variabilis*, d'Orbigny. Freehold.

This species seems to be limited to the lower marl bed.

5. *Cristellaria acutauricularis*, (Fichtel and Moll). Vincentown, Timber Creek.

6. *Cristellaria articulata*, Reuss. Vincentown, Mullica Hill, Timber Creek.

Professor Brady considers this species a thick variety of *Cristellaria rotulata*.

7. *Cristellaria cassis*, (Fichtel and Moll). Vincentown.

8. *Cristellaria crepidula*, (Fichtel and Moll). Vincentown, Mullica Hill.

9. *Cristellaria projecta*, n. sp.

Test complanate, smooth, elongate oval, resembling *Cristellaria cassis* in general contour, but differing from that species in the absence of the marginal keel; margin rounded; chambers numerous, about twelve in final convolution, narrow, elongated; septa distinct, convex; ultimate chamber truncate, anterior margin straight, aperture small, narrow-elliptical, with crenulated margin.

Length, 4.7 mm.; breadth, 2.4 mm.

Locality. Vincentown.

10. *Cristellaria cultrata*, (Montfort). Freehold, Bruere's pits, Marlboro, Mullica Hill, New Egypt, Swedesboro, Timber Creek.

This species is a common form at Freehold and is beautifully preserved. The width of the marginal keel is variable, as is also the number of chambers. It is similar to *Cristellaria rotulata* with the addition of the keel. Specimens of *Cristellaria cultrata* from New Egypt and Swedesboro are not smooth as in typical forms, but are marked externally by raised septa.

11. *Cristellaria gibba*, d'Orbigny. Vincentown, Mullica Hill, Timber Creek.

12. *Cristellaria italica*, Defrance. Swedesboro, Blue Ball, Mullica Hill.

13. *Cristellaria megapolitana*, Reuss. Freehold.

14. *Cristellaria mamilligera*, Karrer.

Test complanate, nearly circular, anterior margin truncate, posterior margin slightly carinate; surface ornamented with a number of large raised ridges and tubercles in the umbilical region; septa depressed, the depressions partly filled by extension of the exogenous material which forms the ridges; chambers large, slightly arcuate, eight or nine in final convolution, septal plane narrow, surrounded by definite border. Aperture an elongated oval opening surrounded by a crenulated margin.

Diameter, 1.74 mm.

Locality. Blue Ball.

This species is very rare in the green marl of Blue Ball and has not been identified elsewhere. It is of large size and the surface ornamentation is very peculiar and interesting.

15. *Cristellaria rotulata*, (Lamarck). Vincentown, Blue Ball, New Egypt, Mullica Hill, Timber Creek, etc.

One of the most common species.

16. *Cristellaria trachyomphala*, (Reuss). Blue Ball.

17. *Cristellaria triangularis*, (d'Orbigny). Freehold.

18. *Cristellaria wetherellii*, (Jones). Vincentown, Mullica Hill, Timber Creek.

19. *Discorbina bertheloti*, (d'Orbigny). Blue Ball, Timber Creek.

20. *Frondicularia angusta*, var. *dimidia*, Bagg. Vincentown.

This Frondicularia is very closely allied to the European form, but differs principally in the number of chambers which is less than half of those found in European specimens. It is quite a common form in the limesand at Vincentown.

21. *Frondicularia archiaciana*, d'Orbigny. Vincentown.

22. *Frondicularia clarki*, n. sp.

Test complanate, smooth, consisting of about twelve chambers, ultimate chambers marked by a narrow tube which unites with the oral opening. Primordial chamber globose, elevated above the general contour of the shell. Septa apparent externally as slight ridges. Shell dull-gray, smooth. Aperture terminal.

Length, 3.2 mm.; breadth, 1. mm.

Locality. Vincentown.

This large and beautiful Frondicularia is quite similar to *Frondicularia inversa*, Reuss, but differs from that species in the size of the spine on the primordial segment, in the greater prolongation of the ultimate segment, and in the proportionately greater width. I have named this species after Prof. W. B. Clark.

23. *Frondicularia inversa*, Reuss.

Test complanate, leaf-like, elongate, smooth, broadest near the middle, tapering towards the anterior and posterior ends by straight wedge-shaped lateral margins; peripheral edges square. One lateral surface slightly curved along the median line, opposite surface approximately flat. Chambers, ten to twelve, narrow, elongate, nearly parallel to peripheral edges. Primordial chamber oval, elevated, marked by a median ridge, mucronate. Aperture rotund, crenulated.

Length, 2.82 mm.; breadth, 1. mm.

Locality. Freehold.

24. *Frondicularia lanceola*, Reuss.

Test very elongate, lanceolate, tapering sharply to an acute point at the primordial end. Segments numerous, twelve or more, quadrangular in cross-section as in the figure of Professor Reuss. Septa depressed sharply, so that the chambers appear elevated into oblique folds. The surface is smooth and glistening, differing in that respect from the type of *Frondicularia lanceola* and *Frondicularia angusta*, Nilsson. Peripheral margin limbate. Ultimate chamber extended. Primordial chamber nearly radiate.

Length, 3. mm.; breadth, 0.6 mm.

Locality. Freehold.

25. *Frondicularia major*, Bornemann. Vincentown.

26. *Frondicularia reticulata*, Reuss. Freehold.

This is one of the most beautiful of all Frondicularia, and is at the same time very rare. I have only one specimen from Freehold and it is interesting to know that Professor Reuss records the single occurrence of a perfect specimen from the Cretaceous of Lemberg, Germany.

27. *Flabellina sagittaria*, (Lea). Vincentown, Blue Ball, New Egypt, etc.

This Foraminifera was the first species to be described from the New Jersey greensands under the genus Palmula.

28. *Gaudryina pupoides*, d'Orbigny. Vincentown.

29. *Globigerina bulloides*, d'Orbigny. Vincentown, Swedesboro.

30. *Globigerina bulloides*, var. *triloba*, Reuss. Vincentown.

31. *Globigerina cretacea*, d'Orbigny. Freehold, Quinton, Vincentown, Mullica Hill, Timber Creek, etc.

32. *Haplophragmium concava*, n. sp.

Test arenaceo-siliceous, rough, of a dull gray color, consisting of eight or nine chambers, concave upon the inside edge, giving the form of a nearly triangular outline in transverse section; chambers very variable in size; ultimate chamber largest and very slightly elevated in the central portion; septal lines straight, marked by definite deep constrictions; aperture a large, elongated, oval opening, situated towards the outside edge of the ultimate chamber and nearer the convex side.

Length, 1 mm.; breadth, 0.43 mm.

Locality. Blue Ball.

33. *Lagena globosa*, (Montagu). Vincentown, Mullica Hill.

34. *Lingulina carinata*, d'Orbigny. Vincentown.

35. *Marginulina ensis*, Reuss. Bruere's pits, Blue Ball, Mullica Hill, New Egypt.

36. *Marginulina trilobata*, d'Orbigny. Freehold.

37. *Nodosaria acuminata*, Reuss. Vincentown.

38. *Nodosaria annulata*, Reuss. Freehold, Vincentown.

39. *Nodosaria communis*, d'Orbigny. Cream Ridge, Bruere's pits, New Egypt, Mullica Hill, Timber Creek.

40. *Nodosaria consobrina*, var. *emaciata*, Reuss. Vincentown.

41. *Nodosaria polygona*, Reuss.

Test elongated, tapering to a sharp point below. Surface marked by distinct costae, at first seven, but about two-thirds way up two secondary ribs run in. At first these are small but soon increase in size until they are equal to the primary ribs, and nine equally spaced elevated costae surround the upper chambers. These curve very gently from below downwards, as in *Nodosaria obliqua*. Chambers numerous, short, separated by slight transverse septa, very moderately constricted.

In one of the specimens of this species there is an abrupt ending of the costae at the distal end, giving a collar-shaped appearance to the shell. The ultimate chamber is small, and marked by much finer, more numerous striations than the remaining segments. Aperture small, mammillate.

Length, 10.2 mm.

Locality. Cream Ridge.

42. *Nodosaria filiformis*, d'Orbigny. Mullica Hill, Timber Creek, Vincentown.

43. *Nodosaria farcimen*, (Soldani).

44. *Nodosaria adolphina*, d'Orbigny. Swedesboro.

45. *Nodosaria indifferens*, Reuss. Cream Ridge.

46. *Nodosaria laevigata*, d'Orbigny. Vincentown.

47. *Nodosaria longiscata*, d'Orbigny. Vincentown.

48. *Nodosaria multicostata*, d'Orbigny. Blue Ball.

49. *Nodosaria nitida*, d'Orbigny, Blue Ball.

50. *Nodosaria obliqua*, (Linné). Vincentown, Blue Ball, Mullica Hill, Timber Creek, New Egypt, Harrisonville.

51. *Nodosaria pauperata*, d'Orbigny. Vincentown.

52. *Nodosaria polygona*, Reuss. New Egypt, Blue Ball, Harrisonville.

53. *Nodosaria raphanus*, (Linné). Swedesboro, Timber Creek.

54. *Nodosaria radicula*, (Linné). Timber Creek.

55. *Nodosaria rotundata*, Reuss. Vincentown.

56. *Nodosaria scabra*, Reuss. Vincentown.

57. *Nodosaria spinulosa*, (Montagu). Vincentown.

58. *Nodosaria vertebralis*, (Batsch). New Egypt.

59. *Nodosaria williamsi*, n. sp.

[1] Die Foraminiferen des senonischen Grünsandes von New Jersey. Sitz. Ak. Wiss. Wien., Vol. XLIV, 1861.

[2] Jour. N. Y. Micr. Soc., Vol. VI, No. 2, 1890; Vol. X, No. 4, 1894.

Test elongate-oval, obtusely angular at the proximal end, obtusely rounded above. Surface very finely striate, chambers four to six, short, very slightly constricted. Ultimate chamber truncate, aperture very large, rotund.

This form is similar to *Nodosaria comata*, Batsch, but differs from it in the less distinct chambering, and in the striations of the ultimate segment, which in our form run to the extremity.

Length, 1 mm.

Locality. Swedesboro.

60. *Nodosaria zippei*, Reuss. Freehold, Blue Ball, Vincentown, Harrisonville, etc.

This beautiful species is one of the largest forms found in the New Jersey Cretaceous, and was described by Gabb as early as 1860 under the name *Dentalina pulchra*. Owing to its great length it is very easily broken, so that only a few of the longest specimens are perfect. Dr. Anthony Woodward considers this species identical with *Nodosaria raphanistrum*, but the two species are sufficiently distinct to justify our retaining the name given by Professor Reuss.

An interesting case of dimorphism was observed on one of the specimens of this species. The proximal end of this shell is divided into separate chambers, each of which bears the characteristic number of costae of the species. These two primordial segments are united anteriorly into a typical Nodosarian chamber and the remaining segments are uniform.

61. *Pleurostomella subnodosa*, Reuss. Timber Creek.
62. *Polymorphina communis*, (d'Orbigny). Vincentown.
63. *Polymorphina compressa*, d'Orbigny. Vincentown.
64. *Polymorphina gibba*, (d'Orbigny). Vincentown, Freehold.
65. *Polymorphina lactea*, (Walker and Jacob). Vincentown, Blue Ball, New Egypt, Timber Creek, etc.
66. *Polymorphina lactea*, (Walker and Jacob), elongate variety. Brady, Vincentown.
67. *Polymorphina oblonga*, d'Orbigny. Freehold, Timber Creek.
68. *Polymorphina orbignii*, Zborzewski. Vincentown.
69. *Polymorphina problema*, d'Orbigny. New Egypt, Mullica Hill, Timber Creek.
70. *Pulvinulina karsteni*, (Reuss). Vincentown, Quinton.
71. *Pulvinulina micheliniana*, (d'Orbigny). Blue Ball, Timber Creek.
72. *Textularia agglutinans*, d'Orbigny. Vincentown, Mullica Hill, Timber Creek.
73. *Textularia agglutinans*, d'Orbigny, var. *porrecta*, Brady. Vincentown.
74. *Textularia globulosa*, Ehrenberg. Freehold.
75. *Textularia gibbosa*, d'Orbigny. Freehold.
76. *Textularia sagittula*, Defrance. Vincentown, New Egypt, Timber Creek.
77. *Textularia gramen*, d'Orbigny. Vincentown, Timber Creek.
78. *Textularia turris*, d'Orbigny. Vincentown, Timber Creek.
79. *Tritaxia tortilis*, (Reuss). Swedesboro.
80. *Tritaxia tricarinata*, Reuss. Swedesboro, Timber Creek, Vincentown.
81. *Trochammina*, sp. Vincentown.
82. *Truncatulina akneriana*, (d'Orbigny). Vincentown.
83. *Truncatulina haidingerii*, (d'Orbigny). New Egypt, Vincentown.
84. *Truncatulina lobatula*, (Walker and Jacob). Vincentown, Mullica Hill, New Egypt, etc.
85. *Truncatulina refulgens*, (Montfort). New Egypt, Vincentown.
86. *Truncatulina ungeriana*, (d'Orbigny). New Egypt, Vincentown.
87. *Truncatulina wuellerstorfi*, (Schwager). Vincentown.
88. *Vaginulina legumen*, (Linné). Vincentown, New Egypt, Mullica Hill.
89. *Vaginulina strigillata*, Reuss. Freehold.
90. *Verneuilina polystropha*, (Reuss). Freehold.
91. *Verneuilina triquetra*, (von Munster). Vincentown, Timber Creek, Mullica Hill. This is a very common species.
92. *Vitrewebbina lucris*, Sollas. Vincentown.
93. *Vitrewebbina sollasi*, Chapman. Vincentown.
94. *Pulvinulina reticulata*, Reuss. Freehold.

The Volcanic Series of the Fox Islands, Maine.

By George Otis Smith.

The late Professor Williams called the attention of geologists to the wide distribution of volcanic rocks in eastern North America.[1] The identification of these ancient and metamorphosed volcanics, and their investigation in the different areas in which they occur, were shown to be essential to the solution of the geological problems of the crystalline belt.

One of the localities mentioned by Professor Williams was that of the Fox Islands, in Penobscot Bay, Maine. The presence of volcanic rocks on these islands had been noted by Dodge and Beecher,[2] in their study of some fossiliferous Upper Silurian strata at this locality; and in 1893, Dr. W. S. Bayley, of Colby University, visited the islands, making a brief study of the volcanic area. He showed the existence of great masses of porphyrites, porphyries, basic and acid tuffs, amygdaloids, breccia, volcanic conglomerates, and spherulitic glasses.[3] It is of interest to note that, in 1846, E. Emmons mentioned these spherulitic rocks, describing the development of the hard oval nodules of quartz as due to the great degree of metamorphism to which the slates had been subjected.[4]

[1] Journal of Geology, II, p. 1, 1894.
[2] Am. Jour. of Science, XLIII, p. 412. 1892.
[3] Bull. Geol. Soc. Am., VI, p. 474, 1894.
[4] Taconic System in Maine. Nat. Hist. of N. Y., Part V, Vol. I, p. 100.

The present writer has had the privilege of studying the rocks collected by Dr. Bayley, together with the thin sections made from them. The area has been visited this past summer and the geology of the two islands studied in some detail. Especial attention was given to the volcanic series, which exhibits at this locality such a variety of products of volcanic activity as to particularly favor petrographical investigation. Mention will be made here simply of those portions of the islands occupied by the rocks which plainly represent old lava flows and the accompanying pyroclastics.

This volcanic area comprises the southern part of the island of North Haven and the northern part of Vinal Haven island, containing about five square miles. The area consists of a number of peninsulas and points on either side of the Fox Islands Thoroughfare, with a coast line deeply indented and very bold, affording continuous sections of the volcanic rocks for long distances. The position of the village of North Haven at the center of this area makes the region easy of access.

The Thoroughfare, which is over a quarter of a mile wide in its narrowest part, divides the volcanic area into two parts which are characterized in the main by different rock types. The North Haven portion comprises a series of beds of porphyrites and coarse conglomerates and breccias of volcanic material. A small amount of well-bedded tuff and of quartz-porphyry is also found here. The southern or Vinal Haven area is characterized by a great development of the more acid and glassy rocks, though the porphyrites of the northern area also occur on the northern shore of Vinal Haven. The tuffs are more abundant here, and as on North Haven, they show the general strike of the series to be somewhat north of east, with a dip of about 60° to the south. The tuffaceous beds on Calderwood's Neck[1] present considerable variation from this strike, and probably indicate folding and faulting at this point.

North Haven Area.

The North Haven porphyrites are undoubtedly the oldest members of this volcanic series and seem to overlie conformably the Niagara strata, the age of which was determined by Dodge and Beecher. The best exposure of these porphyrites is in the vicinity of Ames' Knob, north-west of the village of North Haven. In color, the porphyrites are gray, purple or red, in many cases, the gradation being very complete from one color to the other. The feldspar phenocrysts are lath-shaped and abundant, though now badly altered. The fine-grained crystalline ground-mass contains considerable magnetite. At some points, the gray porphyrite presents amygdaloidal and even drusy phases. Above these porphyrites, there is a considerable thickness of a rock which possesses decided conglomeratic characters. The included fragments are wholly of the porphyrites of varying color. In places, however, the rock more resembles a breccia, and microscopic study of a thin section shows the cement between the fragments of basic porphyrite to contain phenocrysts of feldspar, so that the rock may be termed a flow-breccia.

Above this breccia occur more porphyrites, a red one predominating. This contains many feldspar phenocrysts and in the thin section other phenocrysts are noted, which undoubtedly represent original olivine. These are now composed of serpentine, but possess the characteristic habit of olivine and are associated with much magnetite and apatite. There seems, therefore, to be little doubt as to the basaltic character of this rock. Another of the porphyrites is a typical amygdaloid, which shows the porphyritic structure between the amygdules of calcite and quartz.

Associated with these basic lava flows are several beds of tuffs. These are usually of a purplish color and show great variation in size of grain. Some are simply coarse aggregates of porphyrite fragments, while others are composed of microscopic angular particles of devitrified glass. Certain of these tuffs are distinctly stratified, and by the perfect sorting of their material and fine banding seem to indicate subaqueous deposition.

In the immediate vicinity of the village of North Haven, there occur rock-types more acid in character, quartz-porphyry and quartz-porphyry tuff. The yellow quartz-porphyry contains the typical bi-pyramidal quartz phenocrysts, showing some magmatic corrosion, but no evidence of dynamic action such as would produce cracking or develop undulatory extinction. Feldspar phenocrysts are also quite abundant. The ground-mass is micro-granitic. The tuff closely resembles the porphyry, macroscopically, but its fragmental character is clearly seen in the thin section. Fragments of

[1] Calderwood's Neck constitutes the north-eastern part of Vinal Haven Island, and the locality referred to is on the large point forming the northern part of the Neck.

feldspar and quartz crystals are seen; and even when the included quartz crystals retain their characteristic outline, they are badly cracked. Angular fragments of devitrified glass constitute the remainder of the rock. In amount, these acid volcanics are of much less importance in this area than the basic rocks.

Vinal Haven Area.

As has been noted above, the basic lavas occur to some extent on Vinal Haven also. Associated with them on the shore of the Thoroughfare is a gray aphanitic rock, which seems to be diabasic. The relations of this to the overlying tuff point to its geological occurrence being that of a flow, slightly amygdaloidal on its upper surface. The tuffs also occur in this southern area, and have greater development than to the north.

The greater part of the Vinal Haven volcanics are acid felsitic rocks. These undoubtedly represent original glassy rocks, and may be characterized as flow and spherulitic felsites. The former present beautiful banding of pink and black layers of varying width. In some cases this flow structure is so irregular as to deserve to be termed cutaxitic, while in others the flowage lines are extremely delicate and are arranged in eddy-like areas. All these details are splendidly exhibited on the weathered surface of the felsite. The general trend of the flowage lines is very constant in some exposures, and corresponds closely to the bedding of the underlying tuffs. In other places the flow felsite is seen to have been much contorted and even brecciated. Microscopic study shows the flow felsite to depend, in the main, upon the arrangement of trichites, as well as, occasionally, that of chains of small spherulites. An occasional example of perlitic structure also testifies to the original glassy nature of this rock.

The spherulitic rock appears to always overlie the flow felsite, but no sharp lines of separation could be noted. Usually a few small spherulites can be found within the pink lenses and bands of the flow felsite, which then passes gradually into the typical spherulitic felsite. The latter is mostly of a pinkish color, though, sometimes, almost black. The felsites all weather an ashy white and are pulverulent on the surface. The spherulites are very abundant, completely covering the exposed surfaces, at times, ranging in size from that of a pea to several inches in diameter. Often, several are united, forming irregular nodules. The spherulites are compact and felsitic, more rarely hollow and lined with quartz crystals. Microscopical examination of the rock shows the spherulitic structure to be present in all degrees of perfection, circular sections with radial arrangement of fibres, segments and irregularly shaped spherulitic areas, and plumes similar to those described from younger spherulitic rocks. In one section, these plumes have a linear arrangement dependent upon the flow structure; and usually a relation can be seen between the spherulitic areas and the flowage lines, as traced by the trichites. This spherulitic crystallization is plainly original, transitions into a flow-breccia being found, where the spherulitic structure is earlier than the brecciation.

The glass-breccias of this area deserve mention. Macroscopically, the rock is usually black and very compact, rarely showing included fragments. Microscopically, the breccias are seen to be composed of very angular fragments of devitrified glass, in a cement, the character of which necessitates a division into tuff-breccia and flow-breccia. The delicate detail of the flow structure in the glass fragments has been figured by Professor Williams.[1]

The volcanic area, to which attention has been called in these brief notes, deserves fuller investigation; and it is the purpose of the writer to make the geology of the Fox Islands the subject of a more complete study. The relations of the volcanic series to the granite and other holocrystalline igneous rocks, to the Paleozoic sediments, and to the older schists, will be considered with the purpose of determining more fully the geological conditions of the volcanic outbreaks in the Penobscot Bay area.

[1] Op. cit., p. 23.

A Preliminary Note on the Geology of Massanutten Mountain in Virginia. By Arthur C. Spencer.

During the past field season, the writer spent several weeks in a study of the Massanutten Mountain in Virginia securing data for a detailed map of the areal geology, and constructing several sections across the region. The area examined is a mountainous mass forty-five miles long and three to six miles in width situated in Warren, Page, Shenandoah and Rockingham counties, and embracing portions of the Harrisonburg, Luray and Woodstock topographic atlas sheets of the U. S. Geological Survey.

The several ridges out of which the mountain is composed rise from the middle of the Great Appalachian Valley, a broad depression which extends the whole length of the Appalachian Mountains from southern New York to Alabama. This valley, the floor of which is made up of the Valley or Shenandoah limestone, carries along its center, from the Potomac River to Staunton, a continuous although narrow band of the overlying Martinsburg shales, which in the Massanutten Mountain region are in turn overlain by the succeeding members of the Silurian and Devonian, as the result of a deep sag by which the resistant Massanutten sandstone is carried 1000 feet or more below the present drainage of the valley. This formation not alone serves as a protection to the underlying Martinsburg shales, which are thus seen in their full thickness, but includes in its synclinal folds as well, the Rockwood formation, the Lewistown limestone, the Romney shales, and probably also the Jennings formation.

A provisional estimate of the thickness of these several formations, which it is believed further study will not materially change, is as follows:—

	feet.
Fossiliferous shales, probably Jennings formation, exposed	400
Romney shales	900
Monterey sandstone wanting	
Lewistown limestone	100
Rockwood formation	500
Massanutten sandstone	600
Martinsburg shales	3500
Shenandoah limestone, probably	3500

The value of a determination of the thickness of the Martinsburg shales, in its bearing upon the problem of Appalachian structure, is suggested by Mr. Bailey Willis in a recent paper,[1] and it is a satisfaction to find that the thickness as measured corresponds so well with the figure assumed by him, showing that the present fold probably marks a zone of maximum deposition during Martinsburg time. This leaves little doubt but that the syncline is an original syncline of deposition, and that initial dip was imparted to the principal resisting stratum (the Shenandoah limestone) by the additional weight of 2000 feet or more of sediments. Measurements do not show any direct relation between the varying depth of the syncline and thickness of sediments, although such relation was confidently expected.

It must not be supposed that the structure is one of simple flexure, for the great syncline carries smaller folds and these still others; nor are they mere parallel waves, but a series of long canoes making up large basins closed at each end. The mountain is divided into two such basins of nearly equal length, though the southern is really double. The northern is the wider and deeper of the two, and contains Passage Creek, a stream of peculiar interest.

Passage Creek is a consequent stream flowing in a synclinal valley of its own excavation, but contrary to the ordinary course of such streams it has not found an outlet in the side of the basin but has cut a gap at the very apex. Professor Davis says that there is not a single case of this kind in Pennsylvania,[2] nor does he mention having elsewhere observed an instance of the kind. Whether this exceptional adjustment is due to the presence of a fault or is inherited from an older stream, or the result of early tilting, has not been as yet determined.

There are evidences of two well defined base levels in the region. According to Keith,[3] the older probably corresponds to the Cretaceous peneplain of Pennsylvania and New Jersey. Its remnants have an altitude of from 1800 to 2800 feet, indicating a somewhat irregular surface sloping to the north-east. The younger level is referred to Tertiary erosion which was of too short duration to degrade the harder and more resistant rocks.

The numerous knobs from 500 to 1000 feet above the Cretaceous level, and most of all Short Mountain, with its level summit 500 to 700 feet above the adjacent ridge of Massanutten, give strong indications of an older base-level surface. However, it must be remembered that in other regions similar features have usually been classed as residuals.

Later oscillations are indicated by gravels capping the hills along both branches of the Shenandoah, but no attempt at mapping their distribution was made. That they are contemporaneous with similar deposits cited by

[1] Mechanics of Appalachian Structure. U. S. Geol. Surv., Thirteenth Ann. Report, 1894, p. 254.

[2] Rivers and Valleys of Pennsylvania. Nat. Geog. Mag., Vol. I, 1889, p. 225.

[3] Geology of the Catoctin Belt. U. S. Geol. Survey, Fourteenth Ann. Report, Pt. 2, 1895, p. 354, et seq.

Hayes, in Georgia, and referred to Lalayette or Columbia depression,[1] seems highly probable.

At the Harrisonburg end of South Massanutten, the western rim, representing the Cretaceous level, has an elevation of 2800 feet for about six miles, while Laird's knob, terminating a westward lying spur, is 3300 feet. Opposite Strasburg the elevation is 2000 feet, but the height decreases uniformly to the south-east for thirteen miles, where it is only 1700 feet, soon rising, however, to 2700 feet at the prow of Powell's Fort canoe. Between the two ends of the mountain we find a difference in elevation of 800 feet. At Harrisonburg the elevation of the Tertiary plane is over 1500 feet, at Strasburg, 800. The fall of the Shenandoah River between the same limits is 500 feet.

From the completeness of Tertiary base leveling, it may be assumed that the fall was much less than at present, so that 350 to 400 feet may be taken as the amount of post Tertiary deformation, leaving only 100 to 150 feet due to earlier tilting.

That there has been deformation at a very recent date has been pointed out by Keith,[2] though his statement, that the grade of the north fork is much greater than that of the south, seems to be somewhat at fault, since the river distance between the 500 and 1000 foot contours (as measured upon the topographic sheets of the U. S. Geological Survey) is only four miles greater on the south than on the north fork of the Shenandoah. On both branches the grade between the 700 and 900 foot contours is very much less than it is either above or below. This indicates that both streams have been dammed, which would require more than the simple eastward tilting suggested by Mr. Keith. Either eastward tilting has been accompanied by warping or there has been local tipping in an opposite direction at the north end of Massanutten Mountain.

The iron ores of Massanutten Mountain have been of considerable importance, and it is only a few years since the last of the local furnaces went out of blast. The ores are found in the shales of Rockwood age, and have been regarded as resulting from the wasting of that formation. At present no further light can be thrown on the subject of their origin since they are nowhere accessible.

The manganese deposits occur in the narrow valley separated from the wide or Big Fort valley by an anticlinal ridge of Massanutten sandstone. Along the bottom of this valley the ore has been mined at several points. The valley is not of simple synclinal structure, but a low anticline of Massanutten sandstone is to be made out along its axis. It is in this formation that the ore is found in a vein-like deposit following the stratification of the sandstone, and dipping with it at an angle of from 30 to 50 degrees. The mineral layer varies in thickness from a few inches to about nine feet. At the principal opening the hanging wall is a quartzitic conglomerate while the foot wall is a rotten but rough sandstone. The ore is mostly crystalline but also occurs as a cement in the sand rock. Mining has been carried on by tunneling and by a shaft 110 feet in depth.

It should be noted that this ore mass is found in the Upper Silurian quartzite, for the mines on the eastern side of the valley are in a similar formation of Cambrian age, and it has been doubted that profitable deposits of manganese were found at more than one horizon in the Appalachian region.[3]

Preliminary Discussion of the Geology of the Bordentown Sheet of the Geologic Atlas of the United States.

By George Burbank Shattuck.

The area described below consists of some 235 square miles, and is contained between 74° 30′ and 74° 45′, west longitude, and 40° and 40° 15′, north latitude. Throughout this region the geological relations are so closely dependent on the topography that a description of the latter is necessary for a thorough understanding of the former.

Topography.

The area is divided into two clearly defined regions, one comprising the south-eastern, the other the north-western portions of the sheet. The former is characterized by highlands, a part of the "Highland range" described by Professor Clark in his "Preliminary Report on the Cretaceous and Tertiary Formations of New Jersey,"[1] and slope gradually south-eastward from the isolated points constituting the crest of the range, and which somewhat exceed 200 feet, to a general elevation of about 100 feet. The highest points of the ridge rise only 243 feet, one mile south-east of Imlaystown, 234 feet at Red Hill, 206, one mile east of Arneytown, while two outlying elevations, Arney's Mount and Juliustown hill, rise to 230 and 187 feet, respectively.

The north-west face of this range forms a low escarpment which is extensively gullied by tributaries of the Crosswicks, Assiscunk, Rancocas and smaller creeks, which flow to the Delaware River, while the southern exposures which slope gently toward the coast, contain streams with shallow and broad channels. An important feature must not be omitted, namely, that the Crosswicks Creek has succeeded in cutting the ridge with a narrow gorge between Hornerstown and Arneystown. This gorge broadens out to an extensive basin-shaped valley, excavated by the head waters of the Crosswicks, and the drainage which would otherwise flow down the south-east slope to the ocean is drawn out north-westward to the Delaware River.

The north-western region, on the other hand, is a broad tract of lowland, the most of which is considerably below 100 feet in elevation. It is crossed by several large streams entering the Delaware which toward their mouths cut quite to tide level.

Geology.

The formations represented in this area are as follows:

Pleistocene	Columbia.	
Neocene	Lafayette.	
	Chesapeake.	
Cretaceous	Manasquan	Greensand series.
	Rancocas	
	Redbank	
	Navesink	
	Matawan	
	Raritan	
Jura-Trias	Newark.	
Crystalline schists.		

Only the formations from the Raritan to the Chesapeake will be considered at this time. They all strike from north-east to south-west across the area of the sheet and have an average dip of about 30 feet to the mile south-eastward.

Raritan formation (Plastic Clays of Professor Cook).—The Raritan beds lie unconformably on the older formations. Their contact occupies a line parallel with and not far from the Pennsylvania Railroad, but owing to a thick coating of Pleistocene the exact contact is often determined with difficulty. Outliers have, however, been discovered resting on the shales, outside the limits of the sheet, while the pits at the base of the Sand Hills and at Trenton are excavated in this formation.

The beds themselves consist of alternating strata of clays and sands of varying thickness. The uppermost layer, so far as observed in this region, consists of fine white sand, in one instance containing concretions of pyrite. There are few exposures, the best being found along Crosswicks Creek and near Bordentown and Kinkora.

A recent boring at Hightstown, near the border of the sheet, shows the following section:

Top soil	4′		Pleistocene.
Black clay	35′		Matawan.
Fine white sand	27′		Raritan.
Light-colored clay	9′		
Fine compact sand	15′		
Coarse compact sand	10′		
Light-colored clay	4′		
Fine hard sand	8′		
Fine sand, bearing water	36′	6″	
Coarse sand, bearing water	26′	5″	
White clay	8′		
Coarse white sand	23′		
	205′	11″	

With the exception of lignitic, no trace of fossils was discovered.

[1] Hayes, Geology of Coosa Valley in Georgia and Alabama. Bull. Geol. Soc. Am., Vol. 5, 1893, p. 480, and Hayes and Campbell, Geomorphology of the Southern Appalachians. Nat. Geog. Mag., Vol. 6, 1894, p. 89.

[2] Ibid., pp. 273-376.

[3] Penrose, Ark. Geol. Surv., Ann. Rept., 1890, Vol. 1, p. 378.

[1] Annual Report State Geologist for 1892, p. 177.

Matawan formation (Clay Marls).—The Matawan beds overlie the Raritan. The contact line, although buried in most places in this region under late deposits, is, however, visible at several points in the vicinity of Bordentown and Kinkora, from whence it extends north-eastward, passing over Crosswicks Creek between Yardville and White Horse Tavern.

The strata consists of alternating sands and clays, the latter often very arenaceous and of various colors from brown to blue and even black, and at times, especially in the upper beds, highly micaceous. The data have been collected looking toward the separation of the Matawan formation into several sub-horizons at a later time. Numerous characteristic fossils have been found in both the dark and light clays at the pits on Crosswicks Creek near the village of Crosswicks, and at other points in the vicinity.

The Raritan and Matawan formations occupy the broad valley described above which comprises largely the north-western portion of the sheet.

Navesink formation (Lower Marl Bed).—The Navesink formation for the most part is found near the base of the escarpment of the Highland range. Owing to this, as well as to the fact that this formation has an average thickness of nearly forty feet, the area of outcrop is not superficially extensive. The creeks which were above described as cutting the escarpment, cause the contact of the Navesink with the Matawan to assume a very sinuous course. It extends from a point two miles east of Sharon Station to Jobstown and south-westward. The Crosswicks Creek in effecting its passage through the ridge has produced an extensive embayment in the Navesink beds and admits the Matawan formation for a considerable distance to the territory of the former, while the Navesink is in turn allowed the same extension into the territory of the Rancocas formation.

Four distinct horizons may be described in the Navesink beds. At the base is a bright red sand, which in one locality, however, has been found to be of a greenish color. The typical appearance of the red strata is best seen along the road leading from Arneystown to Recklesstown (Chesterfield), and at several points along Crosswicks Creek. Fossils typical for the Navesink formation, although abundant as a whole, are clustered in localities, and not universally distributed. Above the red sand bed is a horizon of light chocolate colored clay, which is abundantly fossiliferous wherever recognized. Although chiefly argillaceous, grains of glauconite occur. This clay bed is followed by a richly fossiliferous and highly typical greensand marl which passes upward into the fourth horizon, a chocolate clay, resembling number two, in which few fossils are found.

Redbank formation (Red Sand).—Lying conformably on the Navesink is the Redbank formation. It strikes in the same general direction as the formations previously described, and on the eastern side of the Bordentown sheet has a thickness of about fifty feet. This thickness rapidly diminishes along both the dip and strike, causing the formation to practically disappear one and a half miles west of Arneystown.

Lithologically the Redbank consists typically of red sand, slightly argillaceous in places. Just beyond the eastern border of the sheet the black sands at the base of the formations are characteristically developed.

Rancocas formation (Middle Marl Bed).—Lying conformably on the Redbank formation is the Rancocas formation. It occurs as isolated patches in the higher points forming the crest of the ridge, as in the area south of Imlaystown where several patches occur as well as on Red Hill and the region about Arneystown. South of this the main belt makes its appearance following the prevalent line of strike. The extensive pits near and at Hornerstown are in this belt.

The formation consists largely of a greensand marl in its lower portions, while above this is a thick bed of fossils containing Terebratula harlani and Gryphala vesicularis, the most persistent fossiliferous zone in the State, which in turn passes upward into a calcareous layer, often indurated to form a limestone that caps the formation.

Manasquan formation (lower portion of Upper Marl Bed).—In the basin about New Egypt, formed by the head-waters of the Crosswicks, lies the most extensive exposure of Manasquan of this region. It is largely covered with Pleistocene deposits, although pits have been opened, however, in the vicinity of Hockamick and Taylors Mount.

The formation overlies the Rancocas conformably, and consists, so far as exposed in this region, of nearly pure greensands. A number of characteristic fossils have been obtained at the marl openings.

Chesapeake formation.—The Chesapeake formation rests unconformably upon the formations below it. It extends north-west from the south-east corner of the sheet as a mantel over the other formations, forming the escarpment from Fountain Green to Springfield, Sykesville and Jacobstown, where it rests upon the Rancocas formation. Owing to the erosion of the head waters of the Crosswicks, about New Egypt, its margin is bent back far to the south-east, and in this portion of the region rests largely on the Manasquan formation.

Prominent outliers of Neocene are found at Arneys Mount and Juliustown Hill, while smaller areas are found on Red Hill and the hills near Imlaystown in all cases resting upon the Rancocas formation.

The deposits in this area consist largely of gravel and sand in which the characteristic angular quartz grains abound, while in the south-eastern corner of the tract the buff and snuff-colored sands are found. In general, however, the coarser sands and gravels predominate.

The Discovery of Fossil Tracks in the Newark System (Jura-Trias) of Frederick County, Maryland.

By James A. Mitchell.

The Newark System, a name first applied by Redfield in 1856[1] and afterward employed by Russell[2] for the red sandstones and shales of the Jura-Trias in the eastern portion of America, has been for many years past a subject of study to geologists interested in the correlation of the various formations of the Mesozoic Period. The deposits extend from Nova Scotia to the Carolinas, following the line of the Appalachian system of mountains and are located in the heart of the most thickly settled portion of our country, a circumstance which has greatly facilitated their study. Owing, however, to the conditions of deposition, the paucity of fossils and the various changes which the strata have undergone, a satisfactory solution of the difficulties relative to the age, origin, extent, etc., of this important system has not been as yet arrived at.

Of the several regions most fully studied may be mentioned the Acadian, Connecticut River Valley, Southbury, New York-Virginia, Richmond and Deep River areas. The peculiarities of each have given rise to various hypotheses insufficiently explanatory of their origin. The glacier hypothesis, which has at various times been advanced, is now no longer considered conclusive, and has given place to the estuary and lacustrine hypothesis which does not exclude the possibility of local glacier action. The theory of estuary or more properly lacustrine origin, would seem to be well supported by the structure and situation of the Maryland area.

Until the recent work undertaken and now in progress under the auspices of the U. S. Geological Survey, little more than a general outlining of the Newark System in Maryland had been accomplished. For the earlier work we are indebted to Ducatel and Tyson, formerly State Geologists, while the later work has been chiefly done by Keith of the U. S. Geological Survey.

A glance at the recent geological map of the State, prepared for the World's Fair Book of Maryland, will show us the general limits of the Maryland area of the Newark System. Entering the State near Emmitsburg, where it has a width of at least 15 miles, we find it taking a southerly course instead of the usual southwesterly direction, since it here runs parallel to the axis of the Catoctin mountains. Throughout the greater part of its course—from Lewistown to Point of Rocks—its width is greatly diminished, ranging from three to four miles. It is flanked on both sides by pre-Newark formations: on the east by Trenton limestone and other metamorphosed Silurian and Cambrian rocks, and on the west by Cambrian sandstone. West of Frederick City there occurs an outcrop of Trenton limestone which causes a break in the continuity of the Newark strata for more than a mile. As in the other areas, so also in this do we find eruptive rocks. Two prominent dikes run for some distance nearly parallel with the general trend of the System, one extending all the way across the State. The bulk of the trap, however, is centered north of Emmitsburg.

Discoveries of fossil foot-prints in the New York-Virginia area have been confined to New Jersey and Pennsylvania, in the latter State the most southern locality being at Goldsboro, York Co., where A. Wanner of York, found fossil algae and foot-prints.[3]

Recently the writer, after an examination of many quarries, has been so fortunate as to find, at one point in Maryland also, a large number of fossil reptilian foot-prints of the three-toed type.

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[1] Amer. Jour. Sci., Vol. XXII, p. 357.

[2] Amer. Geol., Vol. 3, pp. 178–182; Vol. 7, pp. 238–291 and Bull. 85, U. S. Geol. Survey.

[3] The discovery of fossil tracks, &c. Ann. Rept. Geol. Surv. Penn. for 1887, pp. 21–35, pls. 3–13.

The quarry referred to is about one-fourth of a mile north of Emmitsburg, Frederick Co. The place at which the foot-prints were discovered is about 18 feet from the edge of the hill which flanks the banks of Flat Run, a small stream running by the quarry. The beds in which the tracks occur are of firm, fine-grained shaly sandstone of a dull greenish hue, and covered with sun cracks. The dip of the strata is about 55° north-west, which is somewhat greater than that usually found in the deposits of this system, but accounted for in all probability by its proximity to the mountain ranges.

After a thorough examination of all the horizons in the quarry the writer found that there were but two beds which showed fossil tracks. These foot-prints are three-toed, and vary from two and one-half to three and one-half inches in length. The foot-prints on all the slabs obtained are of the same kind except that on one slab there are found two single impressions which differ entirely from the others. One of these appears to be that of a three-toed webbed foot, and the other is a small three-toed marking measuring but one inch in length. On all the slabs we find corresponding distances between single foot-prints, and a turning out of the toes to either right or left, alternately. The average distance of stride is about twelve inches. The difference ranges on either side of this between one and two inches.

On the slabs figured, only the more distinct foot prints are given and, at the same time, only those belonging to clearly defined series.

There are many fainter markings, pointing in every direction, which have been omitted, while in a few cases two or more impressions have apparently been made in the same place (Fig. *B*, 7). At times, also, mud-cracks cut through the foot-prints, portions being left upon either side of the line (Fig. *A*, 2). There are neither body nor tail lines apparent, such as Hitchcock found in the Connecticut River Valley.

The forms are undoubtedly reptilian and belong to the group of the dinosaurs.

Note on the Cretaceous Formations of the Eastern Shore of Maryland. By D. E. Roberts.

No attempt was made by the early geologists of Maryland to correlate the Cretaceous Strata of Cecil and Kent Counties with the typical deposits of New Jersey. The chief difficulty was due to a lack of surface exposures as well as to a complete study of the fossil forms. An excellent opportunity to investigate the deposits and their fossils is afforded, however, by the exposures along the Chesapeake and Delaware Canal, and the head waters and tributaries of the Bohemia and Sassafras Rivers. On account of greater interest in the commercial value of the marls, less attention was paid to the other features of the deposits, the names of only a few fossils having been mentioned as occurring at the head of the Sassafras River.

The early knowledge of the distribution of the Cretaceous is expressed by Ducatel[1] in these words, viz: "The region of country, comprising the geological formation of which the Green Sand or 'Jersey Marl' forms a member, embraces the lower portions of Cecil County, together with the whole of Kent County, on the Eastern Shore, and crossing the Chesapeake Bay, makes its appearance along the Severn, on the Western Shore."

Its presence on the Western Shore was based upon a study of the mineralogical characters of the beds, but in 1888 Professor William B. Clark[2] "brought forward the needed facts to establish its identity across the State" from a study of its fossils. With the same object in view several trips were made by the writer, at Professor Clark's suggestion, to Cecil and Kent Counties during the summer of 1894. Sufficient data and material were collected to clearly establish the identity of the Cretaceous formation on the Eastern Shore, and upon a comparison with the characteristic fossils of New Jersey, the correlation with the Matawan, Navesink, Redbank, and Rancocas Formations.

The general strike is north-east to south-west. The beds dip 30–40 feet to the mile, according to measurement taken along the Chesapeake and Delaware Canal.

[1] Ducatel, Alex., Report of the Geologist for 1834, p. 75, 1835.

[2] William B. Clark, Discovery of Fossil-bearing Cretaceous Strata in Anne Arundel and Prince George Counties, Maryland. [Johns Hopkins University Circulars, 1888, No. 69, pp. 20, 21.]

The chief exposures and their fossils are as follows:

A. Chesapeake and Delaware Canal.

I. Matawan Formation.

Post 218.

Pholadomya occidentalis, Mort.
Turritella encrinoides, Mort.
Turritella vertebroides, Mort.
Odontofusus rostellaroides, Whit.
Baculites ovatus, Say.
Ammonites placenta, De Kay.
Ammonites delawarensis, Mort.

II. Navesink Formation.

Post 157.

Ostrea larva, Lam.
Gryphaea vesicularis, Lam.
Exogyra costata, Say.
Idonearca vulgaris, Mort.

Post 133.

Gryphaea vesicularis, Lam.
Exogyra costata, Say.

Higgins Farm, one mile west of Delaware City, Del.

Ostrea larva, Lam.
Exogyra costata, Say.
Crassatella vadosa, Mort.
Idonearca vulgaris, Mort.
Neithea quinquecostata, Lam.
Cardium dumosum, Con.
Panopaea decisa, Con.
Rostellites nasutus, Gabb.
Volutomorpha bella, Gabb.

III. Redbank Formation.

At the water level of the Canal about three-quarters of a mile east of St. George's (non-fossiliferous), and at the head of Back Creek near Chesapeake City.

B. Bohemia River and its Tributaries.

I. Navesink Formation.

Jones' Farm, head of Burklow's Creek (Great Bohemia Creek).

Idonearca antrosa, Mort.
Cardium dumosum, Con.
Turritella encrinoides, Mort.
Turritella vertebroides, Mort.
Cardium perelongatum, Whit.

Johnson's Farm, Burklow Creek.

Gryphaea vesicularis, Lam.
Exogyra costata, Say.
Cyprimeria densata, Con.
Cardium eufaulensis, Con.
Cardium dumosum, Con.

Head of Great Bohemia Creek.

Merritt's Farm.

Exogyra costata, Say.
Belemnitella americana, Mort.

Bolden's Farm.

Exogyra costata, Say.

Head of Little Bohemia Creek.

Exogyra costata, Say.

II. Redbank Formation.

Bohemia Mills, 100 yards north-east of the Mills.

Ostrea larva, Lam.
Rostellaria hebe, Whit.
Rostellaria spirata, Whit.
Rostellaria compacta, Whit.
Volutamorpha conradi, Gabb.

Pyropsis corrina, Whit.
Natica abyssina, Mort.
Gryphaea vesicularis, Lam.
Exogyra costata Say.
Dentalium falcatum, Con.
Idonearca vulgaris, Mort.
Cardium perelongatum, Whit.
Belemnitella americana, Mort.
Axinea mortoni, Con.
Cancer (sp. undetermined.)

Head of the Mill Pond (Bohemia Mills.)

Terebratula plicata, Say.
Gryphaea vesicularis, Lam.
Exogyra costata, Say.
Axinea mortoni, Con.
Veniella trigona, Gabb.
Cardium perelongatum, Whit.
Belemnitella americana, Mort.

The localities at the Mills and Head of the Mill Pond are exceedingly fossiliferous. At the head of the Mill Pond there is a beautiful exposure about 20 feet high. The south banks of the Great and Little Bohemia Rivers, from a point one mile from George's Landing to their heads, are made up of the Redbank formation.

Near the Catholic Church, at the head of the Little Bohemia Creek, is another typical exposure.

C. Sassafras River (head-waters).

I. Redbank Formation.

Fredericktown (north end of the Bridge).

Ostrea larva, Lam.
Exogyra costata, Say.
Dentalium falcatum, Con.
Turritella encrinoides, Mort.

II. Rancocas Formation.

Jackson's Farm, Herring Creek.

Terebratula harlani, Mort.
Gryphaea vesicularis, Lam.

This is the historical locality mentioned by Ducatel and Tyson. The head of the Sassafras River was alone visited. Further investigation of its lower banks will be made later.

Notes on the Paleontology of the Potomac Formation. By Arthur Bibbins.

During the past two years the writer has devoted considerable time to field work on that highly enigmatic series of mesozoic deposits named by McGee[1] the Potomac formation. The following general account of the results has been prepared at the request of Professor Clark, to whom, also, the writer is indebted for a number of valued suggestions.

Plant Remains.

General Remarks on the Silicified Cycadean Remains of the Potomac Formation.—Mr. Philip T. Tyson[2] appears to have been the first to direct attention to American fossil cycadean trunks, and the five original specimens of the exclusively Maryland fossil which he discovered about thirty-five years ago, at various points between the cities of Baltimore and Washington, may now be seen in the department of geology of the Johns Hopkins University. They were elaborately described by Fontaine,[3] in 1889, and named by him *Tysonia Marylandica.* Within the past few months Ward has made additional notes upon them for publication in his forthcoming memoir on the cycadean remains of North America.

In 1892 an additional trunk was acquired by the Maryland Academy of Sciences, and in the autumn of 1893 two more fragments were found by the writer. Up to this date these were about all the Maryland trunks positively known to paleontologists. These fossils were regarded so very rare[4] that few persons had ever contemplated making a search for additional specimens. Their scarcity, indeed, can only be appreciated by one who has made an attempt to secure a specimen from the field.

The collection of these fossils, which, with the coöperation of the Woman's College of Baltimore, the writer has been successful in obtaining during the past two years, now numbers forty-six trunks and fragments of different trunks. These have been placed in the hands of Professors Lester F. Ward,[1] and F. H. Knowlton of the U. S. National Museum, for study, and a complete illustrated account of them may be expected in the near future. Only a few general remarks will therefore be in order here.

Original Source.—All the Maryland trunks have been found between the cities of Baltimore and Washington. A number of them were found near the middle of the Potomac belt, but the majority were obtained from its western half, and some of the best ones from the western outliers of the formation.

The altitudes of the various points at which the trunks were found range from forty to three hundred feet above tide level, the average being about 125 feet.

Only one (the Link trunk, Fig. E) was positively seen *in situ.* The locality is an interesting one and will be described in detail in a subsequent paper.

Concerning the character of the original beds we can only say, that in case of the trunk just mentioned that it was arenaceous, and not argillaceous, as has been heretofore asserted of the original beds of the Tyson trunks.[2] It seems very doubtful if vegetable tissue of the character of the trunk of the sago would undergo silicification in the "iron ore clays" of the Potomac formation, though vegetable tissue of a firmer texture (Sequoia) sometimes becomes imperfectly so. The circumstance that in a large number of cases the cycadean trunks found at the surface have numerous pebbles and coarse sand very firmly cemented to them, unites with the fact of the high degree of silicification of the trunks themselves in indicating the highly silicious and therefore littoral or sublittoral character of the strata in which they were originally imbedded. It is not to be supposed that many trunks, with leaves attached, which during freshets were swept down the slopes into the Potomac rivers and estuaries, were not frequently borne farther from the shore, or into more quiet water, and deposited upon clay bottoms. At such points sedimentation would be very slow, and the chances would be that the highly cellular and pulpy tissue of the trunks would become disintegrated, or perhaps devoured, before it could be imbedded. Some of its fronds, however, might readily be preserved long enough to be covered, and the conditions would be more favorable here for their permanent preservation than in the more loose and sandy deposits nearer the shore. As a matter of fact we find the remains of the fronds preserved only in clay, or in highly argillaceous deposits, as at Sailor's Tavern on the James, and no fronds have yet been found in the arenaceous deposits which contain the trunks.

The fact that no silicified cycadean trunks have been found in the sandy deposits occurring along the eastern half of the Potomac belt, together with the circumstance that the majority have been found at comparatively high levels (along the present divides separating the larger basins), indicates that this type of vegetation was most abundant during the period of maximum submergence of the Potomac area.

Most of the trunks are considerably compressed from side to side—indicating that they were imbedded in a horizontal position. A few are flattened from above downward. The discoverer of the trunk seen in place (Fig. E) does not remember in what position it was lying, but the fact that it is strongly compressed from side to side may be accepted as sufficient evidence of its horizontal position.

The fossil cycadean trunks and fragments over Potomac areas with which the writer is familiar are considerably fewer in number than similar remains of Conifers. This fact, however, does not signify that plants of the former type were less plentiful in the Potomac landscape than were those of the latter. For it is evident that the trunks of the Conifers were better adapted

[1] Am. Jour. Sci., 1888, p. 120.
[2] First Report, 1860, p. 42.
[3] The Potomac or Younger Mesozoic Flora. Monographs U. S. Geological Survey, Vol. XV, 1889, p. 186.
[4] Tr. Md. Acad. Sci., 1888, p. 7.

[1] Recent Discoveries of Fossil Cycadean Trunks in the Potomac Formation of Maryland. Bull. Torrey Bot. Club, Vol. XXI, 1894, pp. 291-299.
[2] (*a*). Tyson, First Report, p. 42.
(*b*). Tr. Md. Acad. Sc., Vol. I, p. 7.
(*c*). Fontaine, l. c., p. 191.

for preservation both in deep and in shallow water deposits. Moreover, the trunks of Conifers which became silicified in arenaceous deposits, are better adapted for resisting the destructive action of the elements after being brought to the surface by erosion.

That cycadean vegetation of the type under consideration was, in certain districts, entirely or almost wholly wanting where coniferous trees were present, is suggested by the apparent absence of cycadean remains in such districts. For example no silicified cycadean trunks are yet certainly known to have been found in the Potomac, north-east of Baltimore, while similar remains of coniferous trees have been seen at various points at far north as Stemmer's Run. About the same might be said of the Potomac belt in Virginia, where only one cycadean trunk has been reported, while silicified Conifers are not uncommon.

The number of species represented in the collections recently made is not yet determined. Professor Knowlton has been making a careful study of their internal structure, and his results will materially facilitate the pretty difficult task of referring the individuals to their proper genera and species.

Special Plant Deposits,—Muirkirk and Contee.—The iron ore of the Muirkirk region occurs to a considerable extent in an exceedingly tough blue clay impervious to water, and highly charged with lignite ("blue charcoal clay" of the miners). These beds are noteworthy on account of the abundance and excellent preservation of these lignitized vegetable stems and trunks, many of which will probably be found determinable. All of them lie horizontally and are much compressed. The stems also penetrate the masses of carbonate ore, which have evidently been formed about them as nuclei, and it is said that their abundance in the ore materially facilitates its reduction. These nodules of white ore are reported to contain occasional fern impressions, but none of these have yet come under the observation of the writer.

Among the more interesting fossils from the blue charcoal clay are the sequoian cones converted to siderite. According to Professor Ward the specimens hitherto obtained have mostly been secured from the so-called "old engine bank," where they are probably most abundant. They have lately been found at a number of other points in the region of Muirkirk and Contee. From the same beds casts of cones have also recently been obtained differing in species from those usually occurring. A perfect seed was also found and other determinable vegetable structures which will be described in a later paper.

Overlying the bed of "blue charcoal clay" there is frequently found a bed of "brown charcoal clay," which presents the appearance of having been produced from the former by weathering, though inclined to be less compact, considerably arenaceous and therefore pervious to water. The lignitized stems of these beds are much less perfectly preserved, and no cones have been seen in the same. The brown color of the clay has apparently been derived from the limonite produced by the weathering of the original masses of siderite. The vertebrate remains are considerably more abundant here than in the lower beds of "blue charcoal clay," though they too, are less perfectly preserved.

Above these beds of lignitic clay, and commonly forming the uppermost member, is usually found a bed of highly arenaceous clay destitute of lignite and containing a considerable number of quartz and other pebbles. On the surface of this member, in close proximity to the lignitic clays above described, a cycadean trunk was recently found. This bed also contains fragments of silicified coniferous logs (the "petrified chips" of the miners), and one large highly silicified saurian bone was recently taken from the same member, near its contact with the lignitic clays below. It should be remarked that the Latchford mine near Contee, from which Mr. Tyson obtained one of the original cycadean trunks is about one mile north of the point where the trunk just mentioned was found. About the same stratigraphic relations exist there, and Tyson's cycad probably weathered out of this pebbly loam, (which here also contains much silicified wood), and rolled down upon the exposed surface of the iron-bearing clay, which until now has been regarded its original source.

Arlington.—Attention was first directed to this deposit by Mrs. E. E. Harrison, of Towson, Maryland. It occurs on the estates of Mrs. M. A. Kilbourne ("Locust Grove"), and the adjoining estate of Mr. L. C. Bruster, three-eighths of a mile north-west of Arlington, Anne Arundel County. The point is one mile nearly due east of Jessup, and 260 feet above tide level. The comparatively level topped hill in which the deposits occur forms a part of the divide between the Patapsco and Patuxent depressions. Jessup's (B. & O.) cut, well known to students of the Potomac formation, intersects the same divide one and one-eighth miles north-westward. Other deposits of like character are reported to occur at one or two other points in the neighborhood.

The fern impressions, etc., which occur here are very perfect and often of great beauty. They are found in a species of "red iron ore" of exceptionally fine grain. Mineralogically it would be called a hematitic ocher. Its hardness is about 2. When scratched it presents a bright red line. The ore occurs in angular masses weighing from a few ounces to twenty-five or thirty pounds. These are scattered irregularly through a heavy brown clay from near the surface to a depth of ten feet or more, and have been mined to a considerable extent by "gouging" from the surface.

Many of the masses—particularly those of arenaceous character—do not contain impressions. About one mass out of every ten is found to be fossiliferous, and when the impressions are present at all, they are apt to be very numerous, and in many cases closely matted together.

The fossiliferous as well as the unfossiliferous masses evidently represent the broken remains of one or more comparatively thin layers of ferruginous clay or argillaceous sandstone, such as may frequently be seen at the contact between a sandy and an argillaceous member of the Potomac—as at Locust Point, Baltimore (see beyond). These ledges may have been broken up and redeposited by wave action—perhaps during one of the later submergencies or emergencies of the region—not far from their original source. Those masses which are near enough to the surface to be within reach of the frost have usually been much reduced in size, and have frequently been opened along the plain of some of the larger frond impressions. It therefore frequently happens that the outer surfaces of the fossiliferous lumps bear very fine imprints.

It has been suggested that these masses may have been derived from concretions of carbonate ore, by oxidation, as is frequently the case with the so-called "brown ore" common near the surface of the Potomac formation. Masses of brown ore, thus derived, may occasionally be found in this deposit, but no samples have yet been discovered which contain even a trace of white ore within ("white heart"), as is often the case with ordinary brown ore which has been produced by the oxidation of the white.

No sections occur in the immediate vicinity of this deposit which show clearly the character of its underlying members. The section exposed at the iron mines of Dr. A. S. Linthicum, on an adjoining hill, indicates that the deposit is probably underlain by lignitic clays containing masses of siderite and occasional vertebrate remains. Jessup's Cut, mentioned above, presents, at a depth of ninety feet below the level of this deposit, an extensive bed of lignitized logs lying horizontally.

The number of species represented in the Arlington deposits will amount to two dozen or more. Ferns predominate, and Lycopods, Cedars, and Sequoians are common. Algae of the floridial type and cycads—fronds and fruit (?)—and grasses are occasional. No angiosperms have yet been seen. Neither have any traces of animal remains.

Several silicified cycadean and sequoian trunks have been found in the immediate neighborhood, but it is safe to say they were all derived from an originally overlying arenaceous member.

Hanover.—The masses of siderite of the Reynolds iron mine, near Hanover, Anne Arundel County, has recently yielded a few plant remains which are probably determinable. Workmen state that an occasional fern impression has been seen in the blue clays at this point. This locality is highly noteworthy on account of the fact that two large lignitized coniferous trees were found imbedded here in an upright position, with roots intact. The central portion of one of the trunks and a portion of one of its roots had been replaced by siderite. This interesting mine occurs in one of the hills forming the eastern slope of the basin of Deep Run—a depression which has lately yielded nearly a dozen cycadean trunks. These have evidently been derived from the arenaceous member which overlies the ore bearing clays just mentioned.

Baltimore, Locust Point.—By the courtesy of N. M. Rittenhouse, Esq , of the Baltimore Brick and Terra Cotta Works, considerable new material has recently been obtained from the well known deposits again opened up in his shafts near Covington and Ostend Streets. Opportunities for making collections from these important plant beds occur yearly, and interested persons are not only notified when the workmen reach the proper level, but substantially aided.

FIG. A.

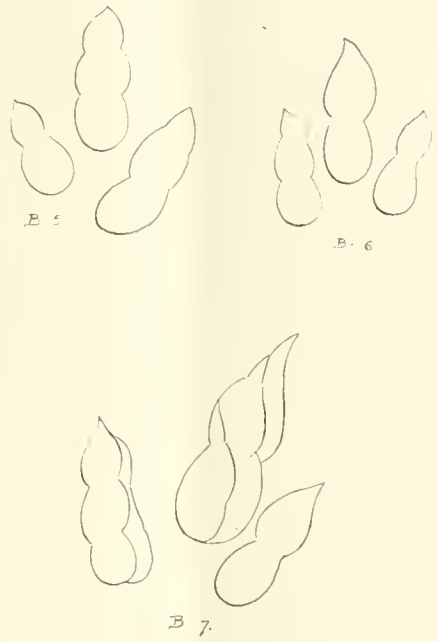

FIG B².

FIG B¹.

FIG. C¹.

FIG. C².

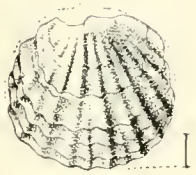

FIG D¹.

FIG D².

FIG. G.

FIG. H.

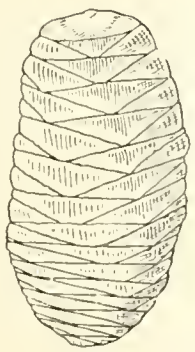

FIG. F.

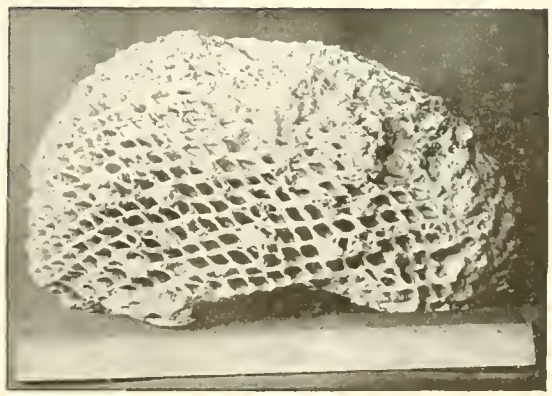

FIG. E.

FIGS. A-B.—Dinosaurian foot-prints.
FIG. C.—Cistella beecheri.
FIG. D.—Cistella plicatilis.
FIG. E —Cycadean trunk.
FIG. F.—Cedar cone.
FIG. G.—Allosaurus tooth.
FIG. H.—Astrodon tooth.

The section as exposed in the shafts of last winter is as follows:

1. Red clay (iron ore)	6′	
2. Mealey loam (iron ore)	7′	
3. Red "alum clay"	10′	
4. Tough "horse clay"	7′	
5. Yellow ocher	4′	
6. White clay		3″
7. "Short" (slickensides) blue clay (logs of lignite and occasional leaf impressions)	7′	6″
8. "Slaty clay" (containing plant bed proper)	7′	10″
9. Indurated ferruginous layer (undulating)		
(*a*) Ferruginous sandstone		1″–4″
(*b*) Commercial paint rock		3″–5″
(*c*) Ferruginous sandstone		1″–5″
10. White Sand containing clay pebbles—not far above tide level	10′	

The plant bed is about ten inches thick and it occurs about four feet from the top of the eighth member.

In one of the shafts, near the base of the seventh member in the above section, a lignitized stump of a Conifer was found imbedded in an upright position. Near by was found a log of similar diameter, imbedded in a horizontal position, and strongly compressed.

Union Tunnel.—This locality is noteworthy on account of its having yielded a single exceptionally perfect cedar cone (Fig. F.) The specimen was found by John W. Lee, Esq., near Aisquith St., about 35 feet below the surface, in a tough blue clay,[1] during the construction of the tunnel. The cone is one and one-half inches in length, one and eleven-sixteenth inches broad, and nine-sixteenths of an inch thick—having been considerably compressed. It is of a dark brown color externally, and the fine longitudinal striations of its scales are perfectly preserved. Internally the tissue is completely changed to lignite. Its weight is 7.25 gr. The cone did not crumble on exposure to the air, as the Potomac lignites usually do, and though never treated with a preservative, it remains as perfect as when removed from the clay, twenty years ago.

Springfield.—Attention was first directed to the deposit by Mr. Irving W. Hoen. It occurs on the property of Mr. John Reynolds on Arlington Av. (Baltimore county), near the old York Road.

The history of this deposit appears to be very similar to that at Arlington,—a ferruginous ledge, rich in plant remains, broken up, and irregularly redeposited, though in this case in a bed containing considerable gravel.

Determinable plant impressions are here much less abundant, and, owing to the highly arenaceous character of the rock, much less sharply defined. They are also of quite different character,—no ferns having thus far been seen. The deposit will yield about a dozen species, including one or two angiosperms.

The more interesting of the remains recently obtained from these special plant deposits above mentioned will be described in detail in a subsequent paper.

Animal Remains.

Muirkirk and Contee.—Tyson was the first to direct attention to animal remains in the Potomac formation, and the observations which he placed on record in 1860 have been amply confirmed by the results of recent work—with a single exception: no cetacean or other mammalian fossils have lately been seen. It seems probable that Tyson mistook some of the huge dinosaurian bones occasionally found in the section to which he refers, for bones of whales,—an error which might easily occur.

In 1887 collections were made by Marsh[2] from one of the mines of the Muirkirk region, under the auspices of the United States Geological Survey, resulting in the discovery of "a new genus of Sauropoda, and other new Dinosaurs."

During the summer of 1894 the writer's attention was directed to additional saurian fossils which had been found in the same mine explored by Marsh, and at various other points apparently yet unexplored. Several of these new localities were examined with some care in the hope both of adding to our knowledge of the species already known and of the discovery of additional forms. Though the work was attended by much difficulty, a considerable collection was obtained in a comparatively short time.

The fossils have been placed in the hands of Professor Frederic A. Lucas,[1] of the United States National Museum for study.

The collection comprises:

Lamellibranchs		2 species.
Gasteropods		1 species.
Bryozoa (doubtful)		1 species.
Fish		2 species.
Crocodile		1 species.
Turtle		1 species.
Dinosaurs:[2]	Allosaurus	1 species.
	Pleurocoelus	1 species.
	Priconodon	1 species.
	Astrodon (tooth)	1 species.

It also includes a number of forms yet undetermined.

Among the more interesting fossils of the collection may be mentioned a tibia, probably of *Allosaurus*, which measures ten inches in width, and thirty-two inches in length, exclusive of the ends, which are lacking. In the same beds ("brown charcoal clay") and at about the same level, were found fragments of other bones of similar dimensions, and a tooth (Fig. G)[3] probably belonging to the same individual. Half a mile distant in a bed of similar character a single vertebra was found which is probably referable to the same species.

Among the rarest fossils of the collection is the tooth of *Astrodon* (*Johnstoni* Leidy?). Tyson discovered the first two specimens of this tooth near Bladensburg, about 1859. Dr. Christopher Johnston made sections of one of them for microscopical study, and very briefly refers to them in a "Note upon Odontology"[4] as the teeth of "*Astrodon*"—a name which he coined descriptive of the appearance of the dentine in cross-section. They were subsequently described by Dr. Leidy,[5] who named the reptile *Astrodon Johnstoni* in honor of Dr. Johnston. These teeth, with the one lately obtained (Fig. H), constitute the only known vestiges of this Dinosaur.

The character of the deposits about Muirkirk and Contee which contain the plant and animal remains has already been described.

The section is briefly as follows:

Quaternary.	
1. Gravel, locally indurated	10′
Potomac.	
2. Arenaceous clay, containing silicified remains of Conifers, Cycads, and (occasionally) of Vertebrates	15′
3. "Brown charcoal clay," containing "brown charcoal ore" and vertebrate remains	10′
4. "Blue charcoal clay," containing "white charcoal ore," and vertebrate remains fewer in number but better preserved	20′+

The deposits of animal remains occurring in the vicinity of Muirkirk and Contee are mostly in the divide between the Patuxent and Potomac depressions, and are from a hundred to two hundred and sixty feet above sea level. The circumstance that they are considerably more abundant toward the upper limit, and pretty closely associated (vertically) with the remains of Cycads suggests that these reptiles were most abundant about the time of the maximum Potomac submergence, which the presence of the Cycads would indicate to have probably been attended by the warm climate suited to animals of this class.

Patuxent.—Near Patuxent, Anne Arundel county, on the estate of Mr. L. Welsh, three fragments of another huge (silicified) tibia were recently found. A fossil cycadean trunk, and considerable silicified coniferous wood have also been found on the surface of the same estate and hillslope.

Jessup.—About 1886 a large femur (?) was taken from the iron mine of Dr. A. S. Linthicum of Jessup. This was given to the U. S. Geological Survey. Vertebrate remains have also been seen in the mines of the State House of Correction, near Jessup.

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[1] Possibly the same member in which Tyson observed fresh water mollusks. First Report, p. 42.

[2] Am. Jr. Sci., 1888, pp. 89-94.

[1] Science, March, 1895, p. 362.

[2] As determined by Lucas.

[3] The tooth shown in the figure is not the one taken from this bed, but one of apparently the same species taken from the "blue charcoal clay," and lent for study by Hon. Charles E. Coffin.

[4] Am. Jour. Dent. Sc., July, 1859, p. 341.

[5] Sm. Contr. Kn., Vol. XIV, 1865, p. 102.

Hanover.—The next point northward where they have been both reported and found is in the mines bordering the Deep Run depression, near Hanover. A large limb bone was found a few years since at a considerable depth, in one of the mines of Mr. P. R. Wilson, and Mr. C. Van Buren Smith of Wellham's Cross-roads has a silicified fragment of a huge dinosaurian tibia which appears to have come from this neighborhood.

The unusual abundance of silicified cycadean and coniferous vegetation in the valley of Deep Run has already been noticed.

Baltimore.—During the past winter while making collections of plant remains from the shafts at Covington and Ostend streets, an impression was seen much resembling in outline and dimensions the track of a single toe of a Brontozoum-like Dinosaur. It occurred in the fossiliferons "slaty clay" near the plant bed. It was carefully removed, but, being fragile, was destroyed in transportation.

Stemmer's Run.—Vertebrate remains have lately been reported in the vicinity of Stemmer's Run. Independent of these rumors the character of the deposits north-east of Baltimore is such as leads us to expect to find in that section fossil remains, both vegetable and animal, similar to those occurring between Baltimore and Washington.

REPORT OF THE WORK OF THE GEOLOGICAL DEPARTMENT DURING THE PAST YEAR.

At the opening of the last academic year, the Geological Laboratory and collections were moved into new quarters on the second and third floors of Hopkins Hall, where nearly twenty rooms had been fitted up to receive them. The facilities of the department have been much increased by the transfer, commodious accommodations being furnished for all features of the work.

Dr. E. B. Mathews, appointed Instructor in Mineralogy and Petrography, began his work at the opening of the year. The arrangements made with Mr. G. K. Gilbert and Mr. Bailey Willis, of the U. S. Geological Survey, resulted in important courses of lectures—the former dealing with the subject of Physiographic Geology, the latter with that of Stratigraphic and Structural Geology.

During the year the following courses of instruction were given:

(*a*) General Geology, by Professor Clark and Dr. Mathews. *Four lectures and one afternoon of practical work each week throughout most of the year.*

(*b*) Paleontology, by Professor Clark. *Three lectures each week, from December to April.*

(*c*) Organized Geological Work, by Professor Clark. *One lecture each week during March and April.*

(*d*) Petrography, by Dr. Mathews. *Three lectures each week throughout most of the year.*

(*e*) Physiographic Geology, by Mr. Gilbert. *Two lectures each week from January 1st to February 15th.*

(*f*) Stratigraphic and Structural Geology, by Mr. Willis. *Two lectures each week from February 15th to May 1st.*

(*g*) Geological Conferences. *Fortnightly, from November 15th to April 1st.*

(*h*) Student Lectures. *Fortnightly, from November 15th to April 1st.*

The laboratories were open daily to students from 9 a. m. till 5 p. m.

Original Work and Publications. Geological studies were continued by Professor Clark upon the Cretaceous and Tertiary formations of New Jersey under the auspices of the U. S. Geological Survey and State Geological Survey, with the co-operation of Messrs. R. M. Bagg and George B. Shattuck, students of the department. Professor Clark also carried on further investigations upon the Mesozoic and Cenozoic Echinodermata of the United States and the Eocene Fauna of the Middle Atlantic slope, the latter work being brought to a conclusion and an extended report prepared. Several papers upon phases of Atlantic Coastal Plain Geology and Paleontology were read before geological societies and subsequently published.

Dr. Mathews carried on investigations upon the granites of the Pike's Peak region in Colorado, under the supervision of Dr. Whitman Cross, of the U. S. Geological Survey, with whom Dr. Mathews had been associated during the previous summer. A paper on this subject was presented at the Baltimore Meeting of the Geological Society of America. Several studies were also conducted upon mineralogical topics, and an article prepared upon "Some Flattened Garnets from North Carolina."

Three candidates came forward for the degree of Doctor of Philosophy in June, two of whom had held Fellowships during the year. Mr. H. S. Gane, Fellow in Organic Geology, presented a thesis upon "The Neocene Corals of the United States." During the past summer he has been connected with the U. S. Geological Survey in Colorado in the study of the Mesozoic formations. Mr. S. W. Beyer, Fellow in Inorganic Geology, presented a thesis upon "The Sioux Quartzite near Sioux Falls in South Dakota, with especial reference to an Intrusive Diabase;" this and other investigations being conducted under the auspices of the Iowa Geological Survey. Mr. R. M. Bagg presented a thesis upon "The Cretaceous Foraminifera of New Jersey," while at the same time continuing field work under the supervision of Professor Clark, upon the Cretaceous formations of New Jersey.

Several investigations were carried on by the other members of the department. Mr. L. M. Prindle made a study of an andalusite contact zone near Washington; and during his summer vacation, of the Paleozoic formations of eastern New York, under Professor T. Nelson Dale, of the U. S. Geological Survey.

Mr. George O. Smith took up for examination the volcanic area of the Fox Islands, Maine, and during the summer was associated with Mr. Bailey Willis in a study of the eruptive rocks of the Cascade Mountains in Washington. Mr. George B. Shattuck has been preparing a report upon the Shoal Creek Fauna of Texas, and at the same time carrying on field work under the direction of Professor Clark in New Jersey. Mr. A. C. Spencer has been engaged in a study of the Massanutten Mountain in Virginia, under the direction of Mr. Bailey Willis. Mr. D. E. Roberts has been investigating the Cretaceous formations of the Eastern Shore of Maryland.

Excursions. Numerous short excursions were made during the autumn months into the surrounding country, both in the Coastal Plain and the Piedmont Plateau, under the guidance of Professor Clark and Dr. Mathews. Two longer excursions were made in May—the first for a study of the Cretaceous-Tertiary formations for fifty miles along the banks of the Potomac River, from Washington southward, and the second to the Caverns of Luray, the Natural Bridge, and the Massanutten Mountain in Virginia—the latter expedition being under the guidance of Mr. Willis.

Coöperation. The U. S. Geological Survey has continued to assist the geological work carried on at the University by facilitating field work in Maryland and in New Jersey.

Material assistance has likewise been received from the State Geological Survey of New Jersey.

The Maryland State Weather Service, organized in 1891, has further extended its work during the past year. New stations have been added from time to time, until now nearly every portion of the State is represented. Weekly Crop Bulletins and Monthly Meteorological Reports have been published. Opportunities have been open to the members of the department to take part in the work of the bureau whenever they desired.

Professor Clark continues as the Director of the State Weather Service, representing the Johns Hopkins University; Professor Milton Whitney as Secretary and Treasurer, representing the Maryland Agricultural College; and Dr. C. P. Cronk as Meteorologist in charge, representing the U. S. Weather Bureau. The three officers mentioned constitute a commission appointed by the Governor.

Scientific Societies. During the Christmas holidays the Geological Society of America held its annual meeting in the new Geological Laboratory. The gathering was largely attended, and many important papers were presented.

The fortnightly meetings of the Geological Society of Washington were regularly attended during the winter by the instructors and students of the department, all of whom had been elected as non-resident members. As the results of many of the most noteworthy investigations of the year were presented at these gatherings, great benefit was derived by those in attendance.

Several members of the department also became members of the National Geographic Society, and availed themselves of its privileges.

Apparatus and Collections. Many important additions were made to the apparatus and collections during the year. The purchase of a stereopticon has made it possible to illustrate many of the conrses with lantern views,

while the large increase in maps has materially aided the work in every direction. By correspondence with the various Geological Surveys of this and other lands, large numbers of maps and reports have been obtained, either as gifts or by exchange. Several important collections of rocks and fossils have likewise been acquired, the most extensive representing the Permian and Cretaceous of Kansas and Indian Territory.

REPORT OF THE WORK OF THE MARYLAND STATE WEATHER SERVICE DURING THE PAST YEAR.

The Maryland State Weather Service, which was organized in May, 1891, under the joint auspices of the Johns Hopkins University, the Maryland Agricultural College, and the United States Weather Bureau, has been carried on since the Spring of 1892, by the same institutions, under authority granted by the Legislature of the State, which at the same time appropriated a sum of two thousand dollars annually for the expenses of the work. This amount, which is intended primarily to defray the cost of printing, admits of the publication of a large amount of data relating to the climate and physical features of the State.

Monthly Meteorological Reports, extending throughout the year, and Weekly Crop Bulletins, covering the growing and harvesting seasons, have been published. That these publications are appreciated by the people of the State, is evidenced by the hearty support they have given in rendering information in regard to the weather and the crops, and by the general and complete publication of reports by the newspapers of the State.

Two thousand copies of each of the Meteorological Reports and Weekly Crop Bulletins have been printed and distributed.

In addition to the regular publications, a series of ten large Climatic Charts, with explanatory notes, has been prepared, which represent the seasonal and annual temperature and rainfall of the State. To these have been added recently hypsometric and drainage maps, while others are in course of preparation. The presentation in this graphic manner of the typical features of Maryland climate will be much more readily comprehended than the tabulated statements, and it is intended to distribute them largely to the public schools and other educational institutions, as well as to the public generally.

The Biennial Report to the last Legislature, entitled "The Climatology and Physical Features of Maryland," contains a general review of the climate of the State. It is illustrated by maps, diagrams, and tables, which show at a glance its leading climatic features. This publication, which is distributed free, has been in much demand by those seeking information in regard to the climatic features of the State.

The Maryland State Weather Service is similar in its organization and methods to like services in other States. The personnel consists of voluntary observers, who have been selected at favorable points throughout the State, and of a corps of permanent observers who have been assigned from the National Bureau to take charge of the work at the central office.

The stations connected with the service are of three classes: 1st. Those which report meteorological facts. 2d. Those which send crop notices. 3d. Those which display signals. In a few instances the same person fulfils the duties of all three offices. Connected with the first class there have been 68 observers during the past year, with the second class 333 correspondents, and with the third class 50 display men—making 451 persons connected with the Maryland State Weather Service, besides the officers at the central office. To all of these the fullest praise is due for the important aid they have rendered in the preparation of the weekly and monthly forms and publications since the organization of the service. Nearly all parts of the State are represented, and it is hoped that the number of observers will steadily increase until every section is provided for.

Professor Milton Whitney continues, as Secretary and Treasurer, to represent the Maryland Agricultural College, and Dr. C. P. Cronk, as Meteorologist in charge, the U. S. Weather Bureau upon the commission, of which the Director is the other member.

The results of the past year, indicate a steady growth in the efficiency of the service, as well as an appreciation of its work among the citizens of the State.

ANNOUNCEMENTS.

Sir Archibald Geikie, F. R. S., D. Sc., LL. D., Director-General of the Geological Survey of Great Britain and Ireland, has accepted the invitation of the President and Board of Trustees of the Johns Hopkins University to inaugurate the George Huntington Williams Memorial Lectureship, and has selected October, 1896, as the time for delivering his lectures.

Professor Cleveland Abbe, of the United States Weather Bureau, will give four lectures to the students in Geology upon Climatology in its relations to Physiography. The lectures will be given on January 6, 7, 8 and 9, 1896. The subjects are: 1. Sunshine and Temperature; 2. The Wind; 3. The Rain; 4. Snow and Ice.

Mr. G. K. Gilbert, of the U. S. Geological Survey, will begin his course of lectures upon Physiographic Geology the second week in January, and will lecture four times weekly until about the end of February. This course embraces a discussion of the origin of the forms of the earth's surface and its treatment will include the systematic presentation of a large body of the principles of dynamic geology, especially those which apply to the sculpture of the land by the various processes of erosion. The lectures will be illustrated by maps, models and lantern views.

Mr. Bailey Willis, of the U. S. Geological Survey, will commence his lectures upon Stratigraphic and Structural Geology, as soon as Mr. Gilbert has completed his course, and will lecture twice weekly until the middle of May. This course will consist of a description of the processes which result in the formation and upheaval of sedimentary rocks. Erosion will be discussed with special reference to conditions governing the character of detrital materials. Sedimentation will be considered as a complex process of sorting, distribution and deposition of the waste of land areas, and deformation will be treated as the process which initiates erosion, and also, as applied to folding, as the indirect result of excessive deposition. The mechanics of rock-folding and thrusting will be illustrated both by actual sections of the Appalachians and by experimental results. The whole course will lead to a discussion of the principles which should govern interpretation of the sedimentary record.

Dr. R. M. Bagg has been appointed Assistant in Geology.

The Saturday Geological Excursions, conducted by Professor Clark and Dr. Mathews, have been arranged as follows:

October 19, to Fort Washington on the Potomac River, a region which characteristically illustrates Coastal Plain stratigraphy and topography. Extensive exposures of Cretaceous, Eocene and Pleistocene occur.

October 26, to the Bare Hills, including localities for chromite, rhodochrome, serpentine, opal, stretched tourmaline, etc.

November 2, to Ilchester Gorge, with fine illustrations of gorge erosion, faulting and pegmatite dykes.

November 9, to the Severn River near Annapolis, which affords the finest exposures of the several Cretaceous formations upon the western side of the Chesapeake Bay.

November 16, to Lorelei, where the contact of the Coastal Plain series with the crystalline rocks of the Piedmont Plateau is well exhibited.

November 23, to the Texas limestone quarries, where there are large exposures of recrystallized limestone and dolomite, including accessory phlogopite, brown tourmaline, tremolite, etc.

December 7, to the Upper Marlboro marl beds, the most classic Eocene locality in Maryland, abounding in fossils. The Miocene also occurs here.

December 14, to the Jones Falls quarries, well known for the rarer zeolites, haydenite, laumontite, harmotome, stilbite and heulandite; also for spherosiderite, pyrite, garnets, lepidomelane, microcline, etc.

An extended excursion into the Piedmont and Appalachian regions of Maryland will be made by the students of Geology in May, 1896, under the guidance of the instructors of the department.

THE JOHNS HOPKINS PRESS.

I. The American Journal of Mathematics.

This journal was commenced in 1878, under the editorial direction of Professor Sylvester. It is now conducted by Professor T. Craig, with the coöperation of Professor Simon Newcomb. Seventeen volumes of about 400 pages each have been issued, and the eighteenth is in progress. It appears quarterly, in the quarto form. Subscription $5 per year. Single numbers $1.50. Complete sets, Vols. I–XVII, will be furnished at $90.

II. The American Chemical Journal.

This journal was commenced in 1879, with Professor Remsen as Editor. Sixteen volumes have been issued, and the seventeenth is in progress. Ten numbers are issued yearly. Subscription $4 per year. Single numbers 50 cents.

III. The American Journal of Philology.

The publication of this journal commenced in 1880, under the editorial direction of Professor Gildersleeve. Fifteen volumes of about 570 pages each have been issued, and the sixteenth is in progress. It appears four times yearly. Subscription $3 per volume. Single numbers $1.00. Complete sets, Vols. I–XIV will be furnished for $55.

IV. Studies from the Biological Laboratory.

(Including the Chesapeake Zoölogical Laboratory.)

The publication of these papers commenced in 1879, under the direction of Professor Martin, with the assistance of Professor Brooks. Five volumes of about 500 pages, octavo, and 40 plates each, have been issued.

V. Studies in Historical and Political Science.

The publication of these papers was begun in 1882, under the editorial direction of Professor Adams. Twelve series are now completed and the thirteenth series is in progress. Thirteen extra volumes have also been issued. Subscription $3 per volume. Complete sets, 26 volumes, will be furnished for $57.00.

VI. Memoirs from the Biological Laboratory.

Volume I (Selected Morphological Monographs, edited by W. K. Brooks, Ph. D.), 375 pages, and 51 plates, quarto, and Volume II (Memoir on the Genus Salpa, by W. K. Brooks, Ph. D.), in two parts—one part of text with 396 pages, large quarto, and one part with 57 large colored plates—can now be furnished together. Volume I is no longer sold separately. The price of Volume II is $7.50. The two volumes of Memoirs, bound in cloth, will be sold together for $15.00.

VII. The Johns Hopkins University Circulars.

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